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OFFICE OF NAVAL RESEARCH

Final Report

NAVY COMBAT SEARCH AND RESCUE

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BioTechnology, Inc.
3027 ROSEMARY LANE · FALLS CHURCH, VIRGINIA

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9 Final Report

6 NAVY COMBAT SEARCH AND RESCUE

by

10 Martin G. Every

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FOREWORD AND ACKNOWLEDGEMENTS

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Special thanks go to the following, who provided access to combat Search and Rescue data, for their time, patience, and assistance:

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As a final word, it is only appropriate that we thank all the personnel involved in SAR efforts during the Southeast Asia conflict. After reviewing hundreds of cases of rescue or attempted rescue, one can only be impressed with their complete dedication to a mission "well done."

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INTRODUCTION

This report is part of a series prepared by BioTechnology, Inc. which analyzes aircrew escape, survival, and rescue under the combat conditions found in Southeast Asia (SEASIA). Earlier reports (see references) addressed the conditions and problems which surround the combat ejection, parachute descent, and survival and evasion phases of an escape event. From these studies, several facts stand out relating to combat escape:

- Mean ejection speed was considerably higher than that normally found during operational (peacetime) escape, and the severity of aircraft damage during combat often allowed very little time to prepare for ejection.
- The major injury rate was quite high for combat ejection. Most of these injuries were the result of being close to, or exceeding, the airspeed limits of the safe ejection envelope.
- The large number of killed in action (KIA) cases, for which there are no data, precludes a direct comparison of combat ejection statistics with operational statistics. From the data available, however, when one considers the adverse conditions surrounding these mishaps, the escape systems appear to have worked as designed, with very few fatalities being attributed to mechanical failure of the system.
- The rescue rate was very low, with almost 60 percent being listed as prisoners of war (POW), missing in action (MIA), or killed in action (KIA).

This report addresses primarily the search and rescue (SAR) phase. It describes in a general manner the makeup and continuity of the Navy and Air Force combat SAR structure in Southeast Asia. Particular attention is given to the effectiveness or ineffectiveness of the various phases in the escape-to-rescue sequence. Finally, an attempt is made to define the cost of the Navy's SAR effort and, where appropriate, to offer recommendations for improving future escape and rescue systems.

Effective combat rescue is important for a number of reasons. The primary one, of course, is the moral obligation to provide an aviator with the optimum in escape and survival equipment and thereby to maximize his chances for successful rescue. The moral obligation extends to SAR crews, whose valor and courage was extensively documented during the Southeast Asia conflict, and who must also be provided with the safest and the best equipment. Another reason involves pure economics. The Navy has and is continuing to invest millions of dollars to develop, improve, and maintain ejection systems designed to save the lives of highly trained and hard to replace aircrews. The economics include: the cost of training an aviator which, if he is a Lieutenant Commander, reaches almost one million dollars; the cost of any search and rescue equipment and personnel which might be lost on a rescue mission; the actual cost of every combat rescue mission [In an Air Force study (Walker and Mehaffie, 1974) the average cost of a SAR attempt was placed at $70,510 (in 1973 dollars).]; and the salaries of aircrewmen who successfully eject but are not rescued (prisoners of war), a figure that ran into many millions of dollars for the Vietnam conflict. Finally, there is the intangible but real political cost resulting from the use of prisoners of war as a propaganda weapon in the enemy's war effort.

It is hoped that the data collected during this study will aid in evaluating combat search and rescue techniques and that this information will be used to improve the process, the consequences of which will be increased aircrew recovery rates and a decrease in search and rescue loss rates during any future conflict.

PROCEDURES

Previous BioTechnology, Inc. studies on Naval air combat escape and survivability have resulted in the collection of extensive data on the events and conditions surrounding combat ejection. During these earlier efforts, a comprehensive questionaire covering all phases of the mishap was administered to aircrewmen who were successfully rescued or were captured following combat ejection during Southeast Asia operations. For the repatriated prisoners of war, additional ejection injury information was obtained from medical records on file at the Naval Aerospace Medical Institute in Pensacola, Florida.

Data Collection

The collection of missing and killed in action data for Navy aircrewmen downed in Southeast Asia involved the examination of various files on these aircrewmen to extract information relevant to ejection and/or survival. These records included ONI Intelligence Reports, Commanding Officer reports, SAR messages, Wingman reports, Repatriated Prisoner of War statements, North Vietnamese autopsy reports, and Joint Casualty Resolution Center reports. Two hundred and twenty-three MIA/KIA files were examined for evidence of escape or attempted escape following an air combat mishap.

The data collection efforts for the current study were devoted primarily to obtaining search and rescue information on each Navy Vietnam loss and for those Air Force losses where the Navy was involved in the SAR effort.

The following commands and agencies were visited or contacted by BioTechnology, Inc. personnel to obtain combat search and rescue data:

Command	Data
U.S. Naval Safety Center U.S. Naval Air Station, Norfolk, Virginia	Reviewed and copied microfilm records on files of aircraft losses in SEASIA. Made copies of, or extracted, relevant survival and rescue data from Rescue Reports (OPNAV form 3750/13).
Combat Data Information Center (CDIC), Wright-Patterson AFB, Ohio	Reviewed data and programs dealing with combat losses in SEASIA. Extracted data on Air Force and Navy SAR fixed wing and Navy helicopter losses during SAR in Southeast Asia.

Command	Data
Flight Dynamics Lab., Wright-Patterson AFB, Ohio	Visited in conjunction with above, to discuss current Air Force programs on the practicality of flyaway ejection systems.
POW/MIA Office, Pers OG Navpers, Washington, D.C.	Reviewed individual POW, MIA, KIA files for Navy air-crewmen downed in SEASIA. Data from these files were extracted onto preprinted BioTechnology, Inc. forms. (Files included ONI Intelligence reports, SAR message traffic, Wingman reports, Vietnamese statements, and Vietnamese autopsy reports.
Center for Naval Analyses Washington, D.C.	Obtained computer printouts on Navy and Air Force losses in SEASIA. Data included geographic location of loss, time, type of hit, etc.
Air Force Archives Washington, D.C. Maxwell Air Force Base, Alabama	Reviewed microfilm records of Air Force Rescues. Reviewed for Air Force rescues of Navy personnel. Supplied reports on Air Force SAR and general SAR problems in SEASIA.
Navy Historical Archives Washington Navy Yard	Reviewed and extracted SAR data from selected message and OPREP reports on file. Reviewed CINCPACFLT reports on SEASIA.
HC-6 – Norfolk, Virginia HC-1 – San Diego, California	Discussed problems of combat SAR with various personnel associated with these two helicopter squadrons.
Aerospace Rescue and Recovery Service, Scott AFB, Illinois	Discussed content and availability of Air Force SEASIA rescue information and availability of Air Force technical reports on SAR in Southeast Asia.
NATC Patuxent River, Maryland	Obtained information on status of Gliding Parachute and current work on Air-Air Pick-up and Air-Air Transfer.

SAR data were coded according to the coding manual included as Appendix A in this report. Each incident was reference-coded back to the original BioTechnology incident data file which contains detailed information on the conditions and injuries associated with each event. Injury classifications throughout this report were made using the instructions under Injury Classifications of OPNAV INST 3750.6G. All information in this study which relates to individual mishaps was sanitized to insure compliance with the Privacy Act of 1974.

COMBAT SEARCH AND RESCUE (SAR)

Background

Early in the Southeast Asia conflict, search and rescue often was accomplished on an as-available basis by Air-America units or whatever branch of the service had a suitable vehicle in the area. At that time the Air Force Aerospace Rescue and Recovery Service (ARRS) was not fully prepared for the type and extent of conflict encountered throughout SEASIA. In 1964, the only rotary-wing aircraft available to be deployed in SEASIA was the HH-43B helicopter. Consequently, the ARRS was forced to take helicopter aircraft from other Air Force missions to provide even a partially adequate SAR capability for this combat theatre. From that time through the remainder of the conflict, the Air Force equipment and capability rapidly improved into a highly-efficient and well-equipped force.

In Vietnam, the commander of the 7th Air Force had SAR responsibility for the entire combat area. Operational control was exercised by the 3rd Aerospace Rescue and Recovery Group (3rd ARRGp) located in Nakhon Phanom, Thailand. This group exercised control over the units and attachments assigned throughout SEASIA, who in turn provided SAR coverage over specific areas (Figure 1).

The Rescue Control Center (RCC) was also located in Nakhon Phanom and served as the control point for all rescues. The Navy control center subordinate to the 3rd ARRGp was located in the Gulf of Tonkin (Harbor Master) and was normally aboard a destroyer. This control center worked through the Joint Rescue Control Center at Tan Son Nhut Air Base in South Vietnam, which provided coordinated direction of multi-service forces when involved in a SAR effort.

During a typical SAR, mission control was transferred from the 3rd ARRGp to Airborne Mission Control (King), normally in a HC-130, to the on-scene commander, usually in an A-1 (Spad) or A-7 (Sandy), and then to the helicopter actually on scene performing the rescue, usually either an HH-53 (Jolly Green) or an H-3 (Big Mother).

If an aircraft was downed in the Gulf or in a "coastal" area, the Navy would assume control of the SAR effort. In many of these rescues, the H-2 (Seasprite) helicopter was the primary rescue vehicle.

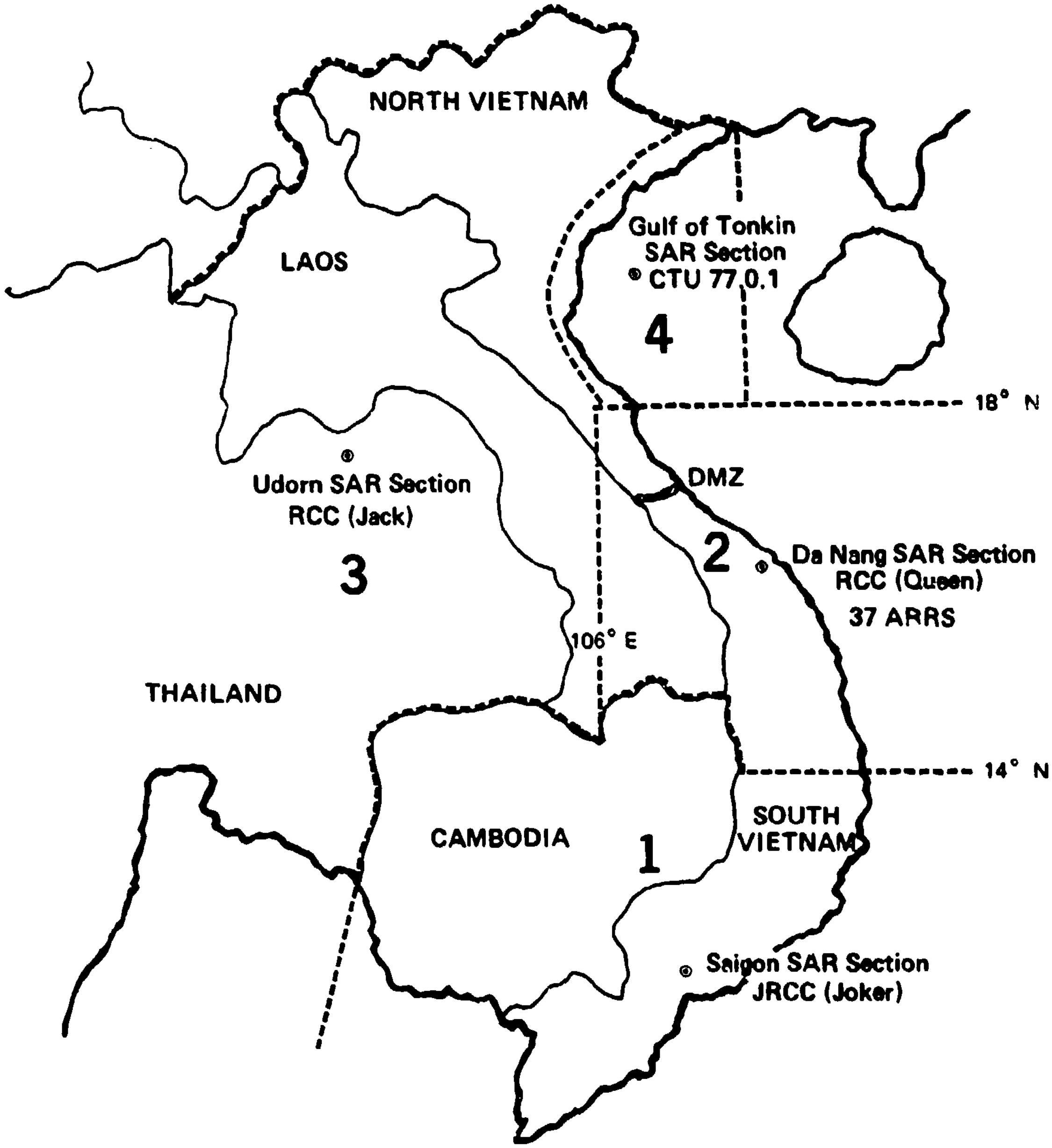

Figure 1. Designated SAR sectors for combat regions of Southeast Asia.

Navy Combat SAR Mission

Operational control and authority for Navy rescue operations was from the Task Force Commander through a forward SAR Coordinator who generally was onboard a destroyer at the north SAR station. The SAR Coordinator and the Task Force Commander were in direct communication with their facilities and with all other SAR-oriented units in their respective areas of operation. It was through this communication net that SAR efforts were initiated and controlled (Reference HC-7 Instruction 3120.1B).

The following is a general description of the location and composition of the naval forces available to the above command for combat SAR effort during the SEASIA conflict. Aboard each carrier on Yankee Station (located at approximately 17°30'N 108°30'E) there was a three-plane helicopter detachment of H-2's, which normally were used for plane guard and had no special equipment or armor. One of these aircraft carriers also carried a four-helicopter detachment of H-3's which were armed, had some armor-plating, and had self-sealing fuel cells. These helicopters were designated as primary vehicles for any aircrewmen downed in the Navy's area of SAR responsibility.

Two SAR stations were continuously maintained, one in the north at approximately 20°N – 107°E and one in the south at approximately 19°N – 106°E. Each station consisted of two destroyers, one with an H-2 helicopter aboard. This H-2 was equipped with armor, self-sealing fuel tanks, and machine guns and was available for SAR effort into North Vietnam.

Prior to an aircraft strike into SEASIA, an H-3 was launched and stayed in orbit over the destroyer SAR station. After approximately eight hours this helicopter was relieved by another H-3. During heavy strikes, two H-3's might be in orbit, one over the north SAR station and one over the south SAR station. The H-2's aboard the destroyer were kept in standby condition on deck. The H-3's were supported by four or more fixed-wing rescue support aircraft (RESCAP). These were often attack-type aircraft (A-1's, A-4's, or A-7's).

Open-ocean rescues which were two or more miles off shore were rarely complicated by hostile activity. Consequently, the search and rescue procedures were very similar to those in a noncombat mishap. The greatest difference was in having to contend with the numerous and severe injuries incurred during the combat escape. The extent of these injuries increased the importance of a quick pick-up and of providing immediate first-aid to the survivor. However, a quick pick-up was the rule since the search and rescue vehicle deployed was usually located only a short distance from the landing area, with the rescue helicopter often having the survivor in sight during parachute descent.

Search and rescue, or attempted rescue, over coastal waters or within enemy territory was quite different. If an airman was known to be down in enemy territory, the immediate question to be answered was, "Can the SAR effort be justified?" Before a helicopter was committed to an overland mission, approval from the forward SAR Coordinator had to be obtained. The final authority to continue the mission rested with the helicopter aircraft commander who had to determine from information at hand whether the mission could be accomplished with a reasonable degree of success.

The combat search and rescue effort is normally broken down into three phases: the search phase, the suppression phase, and the pick-up phase.

If the survivor is not held in visual contact by a wingman, the first task is to locate him as quickly as possible. In dense jungle, as was often found in SEASIA, this job often fell to the fixed-wing aircraft assigned to that SAR mission. These aircraft attempted to find the survivor through his radio and beeper. After fixing a position electronically, the aircraft then moved to a lower altitude and tried to acquire the survivor visually. How much the survivor did to aid in this visual location was largely determined by his physical state, density of vegetation, and proximity of the enemy. Once the location had been established, a recommendation concerning rescue was generally made by the rescue escort (RESCORT) on-scene commander.

Based on intelligence data from search planes, a decision was made concerning the type and amount of suppressive fire which might be needed prior to the rescue attempt. The on-scene RESCORT aircraft evaluated the recovery situation based on two key points—a positive identification of a live rescuee and reasonable assurance of a successful pick-up without the loss of the rescue vehicle. If the decision to attempt a rescue was made, the escort aircraft and rescue helicopter would climb to the safest penetration altitude before being vectored to the downed crewmen. Radio contact with the survivor was made as soon as possible.

Once the on-scene commander felt that hostile fire had been suppressed as much as possible, the helicopter moved in for the pick-up. RESCORT and RESCAP aircraft remained in the area to provide any additional suppressive fire needed and to provide escort for the return to the destroyer or carrier.

Prior to the approach for pick-up, a survivor was requested to use some signalling device to identify his position. Although a smoke flare provided wind information it also attracted the enemy gunners, so it was not used unless specifically requested by the helicopter pilot.

The type of pick-up was governed primarily by the degree of injury to the survivor, visibility conditions, thickness of the vegetative canopy, and the amount and type of hostile fire. In all cases, the pick-up was accomplished as quickly as possible to minimize exposure to enemy fire during this period of extreme vulnerability for the helicopter and crew.

Departure from the area was with maximum power and speed utilizing a pre-planned egress route.

Extent of Navy Combat SAR

The extensiveness of the search effort employed for an aviator downed in SEASIA varied from a rescue helicopter which had the survivor in sight during parachute descent to a massive search effort over North Vietnam utilizing many types of aircraft from all branches of the service over a period of several days. As stated previously, the decision concerning type and extent of search, especially over enemy territory, was based primarily on obtaining positive information, either visually or by radio, that there had been a successful ejection and that the survivor was alive and uncaptured. The wingman for the downed aircrewman was often the first one to report this status. Consequently, his report carried considerable weight as to the extent of any additional SAR effort.

Of the downed Navy aircrewmen in SEASIA who were not reecovered, approximately one third had no formal search because the prerequisites just mentioned were not satisfied.

The following are trends noted for the different groups studied. For the recovered group, search efforts were generally very brief. The location of almost all individuals who were rescued from the open sea was pinpointed, and the rescue vehicle proceeded directly to that point. Even for survivors who went down in North Vietnam, positions were generally fixed prior to or very soon after landing. An aircraft from their strike group would usually remain in the area to verify this location and support the rescue attempt.

For those who were not rescued, search efforts were often quite intensive, in many cases lasting for several days. For the missing and killed in action group, there were generally long searches often involving one aircraft which searched an approximate area of loss for signs of wreckage or for a radio transmission. Many of the long searches involved aircraft downed at sea and for which neither survivors nor wreckage was ever found (Table 1). The search effort for those who later became prisoners of war was of shorter duration because confirmation or high probability of capture usually ended the search effort.

Table 1

Time of Search for POW's and MIA's Where a Formal SAR Effort Was Employed

Hours of Search		1 - 2	2 - 6	6 - 12	12 - 24	24 - 48	> 48	Total
POW	Number	16	6	7	7	4	3	43
	Percent	37	14	16	16	10	7	
KIA MIA	Number	7	13	11	11	11	3	56
	Percent	12	23	20	20	20	5	

Navy Southeast Asia Combat Search and Rescue Summaries

Two hundred and thirty-three Navy aircrewmen were downed during combat and recovered by Navy or Air Force SAR units in known locations in SEASIA. Of this group, over 76 percent were rescued by Navy forces (Table 2). The North Vietnamese rescues were often from heavily defended areas and up to 50 miles inland from the coast. These statistics do not include approximately 30 inland rescue penetrations that were unsuccessful due to capture or inability to locate the survivor. The locations of the Navy rescues of Navy aircrewmen are shown in Figure 2 (in all these figures when two or more rescues were accomplished at the same time at the same location, only one point was used to mark this location). The locations of the Air Force recovery of Navy aircrewmen are shown in Figure 3.

Table 2

Known Location of Rescue of *Navy Aircrewmen* by Navy and Air Force SAR Units in SEASIA

Geographical Area

Rescue Unit	NVN	LAOS	SVN	Gulf of Tonkin	Total Aircrewmen Rescued
Navy	20			158	178 (76.4%)
Air Force	4	23	4	24	55 (23.6%)

During the course of the conflict, the Navy is known to have made approximately 60 recoveries of downed Air Force pilots. At least 7 of these recoveries were in North Vietnam, and many others were in coastal waters which subjected the rescue forces to intense hostile fire during the rescue. The locations of these rescues are shown in Figure 4.

Figure 5 shows the geographical ejection locations for Navy aircrewmen who became prisoners of war. Figure 6 shows the known location of those aircrewmen who were listed as missing or killed in action. If both aircrewmen were captured or killed in the same event, only one point was used to plot the event.

For those survivors who ejected over land, immediate capture proved to be the greatest deterrent to any rescue attempt. Figure 7 plots the cumulative percent of time-to-capture and compares this to the time-to-rescue for land and water rescues. As can be seen, in the first 10 minutes, almost 60 percent of the captures had been effected, whereas virtually no land rescues had been performed. In the first 30 minutes, almost 85 percent of the captures had occurred, whereas only approximately 16 percent of the rescues had been accomplished. This fast capture rate was due primarily to the location of the Navy targets in heavily populated areas, such as Haiphong, Hanoi, and Vinh. Although many of these heavily populated areas were close to the relative safety of the coast, they lacked the dense areas of vegetation which were required for successful concealment and evasion. These areas were also generally heavily fortified, greatly increasing the danger to SAR vehicles coming in to effect a rescue. Table 3 lists the terrain features of the survival locations versus the ultimate status of the Navy survivors. This table illustrates the apparent disadvantages of coming down in an open or heavily populated area.

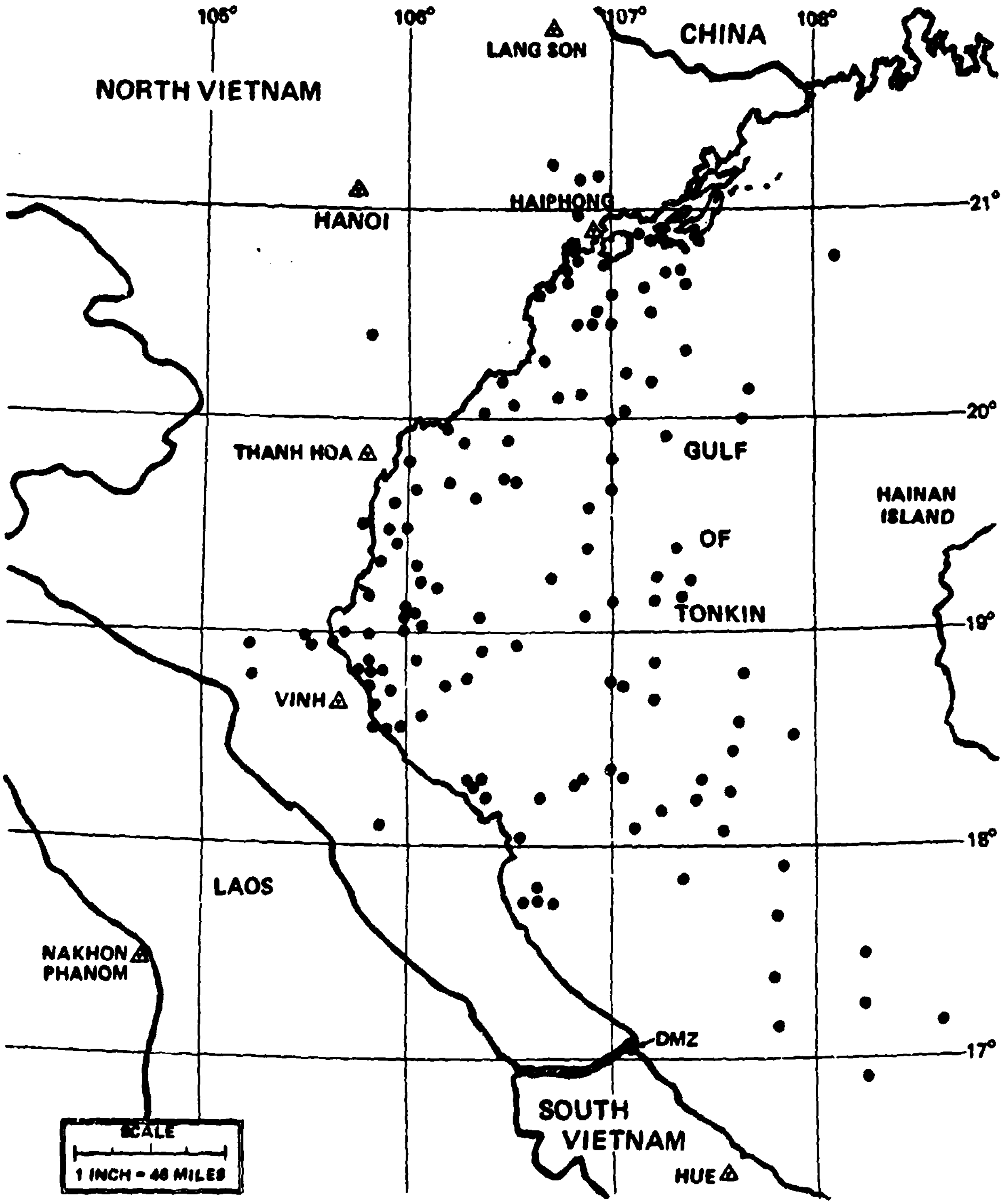

Figure 2. Locations of Navy rescues of Navy aircrewmen during the Southeast Asia conflict.

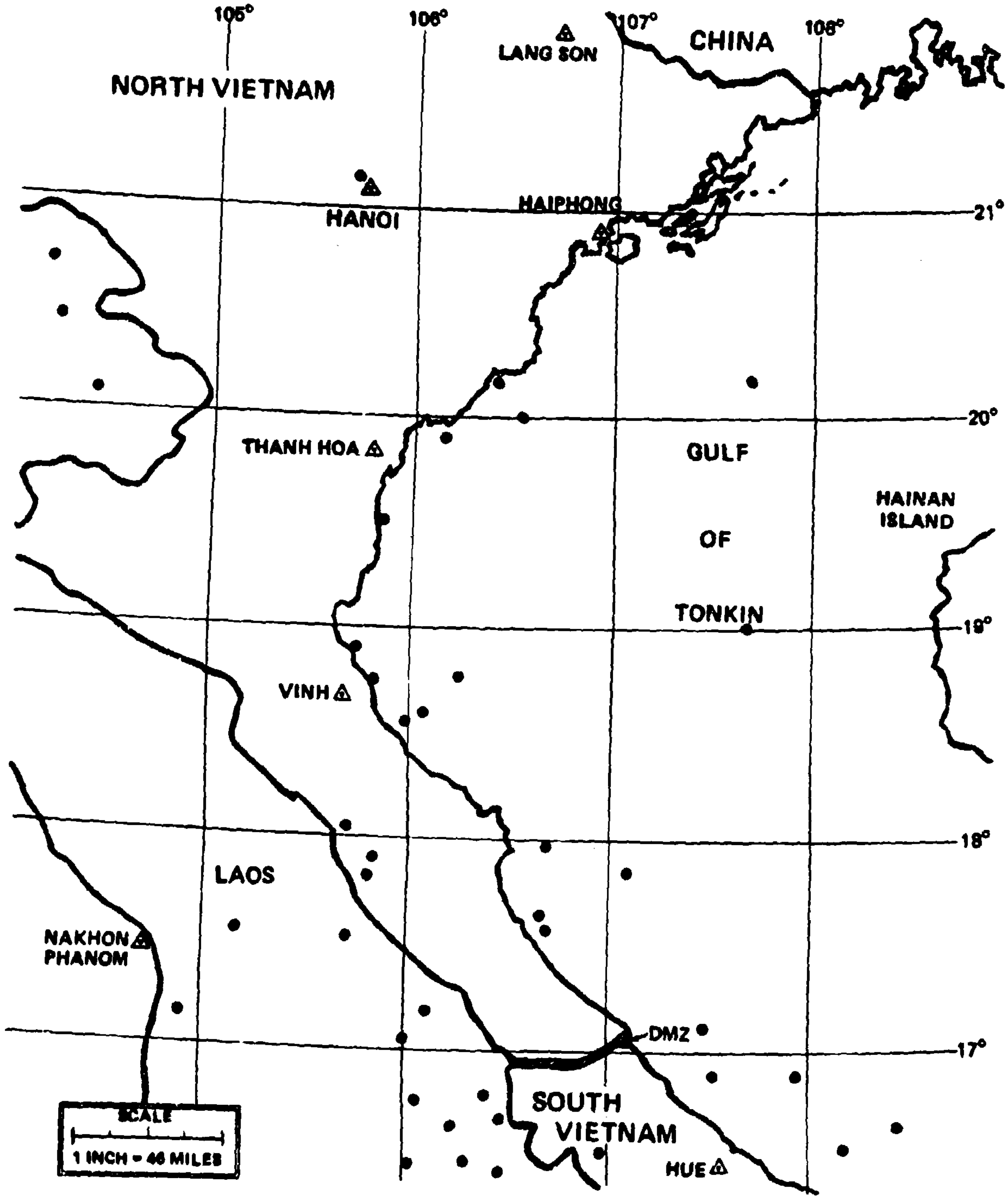

Figure 3. Locations of Air Force rescues of Navy aircrewmen during the Southeast Asia conflict.

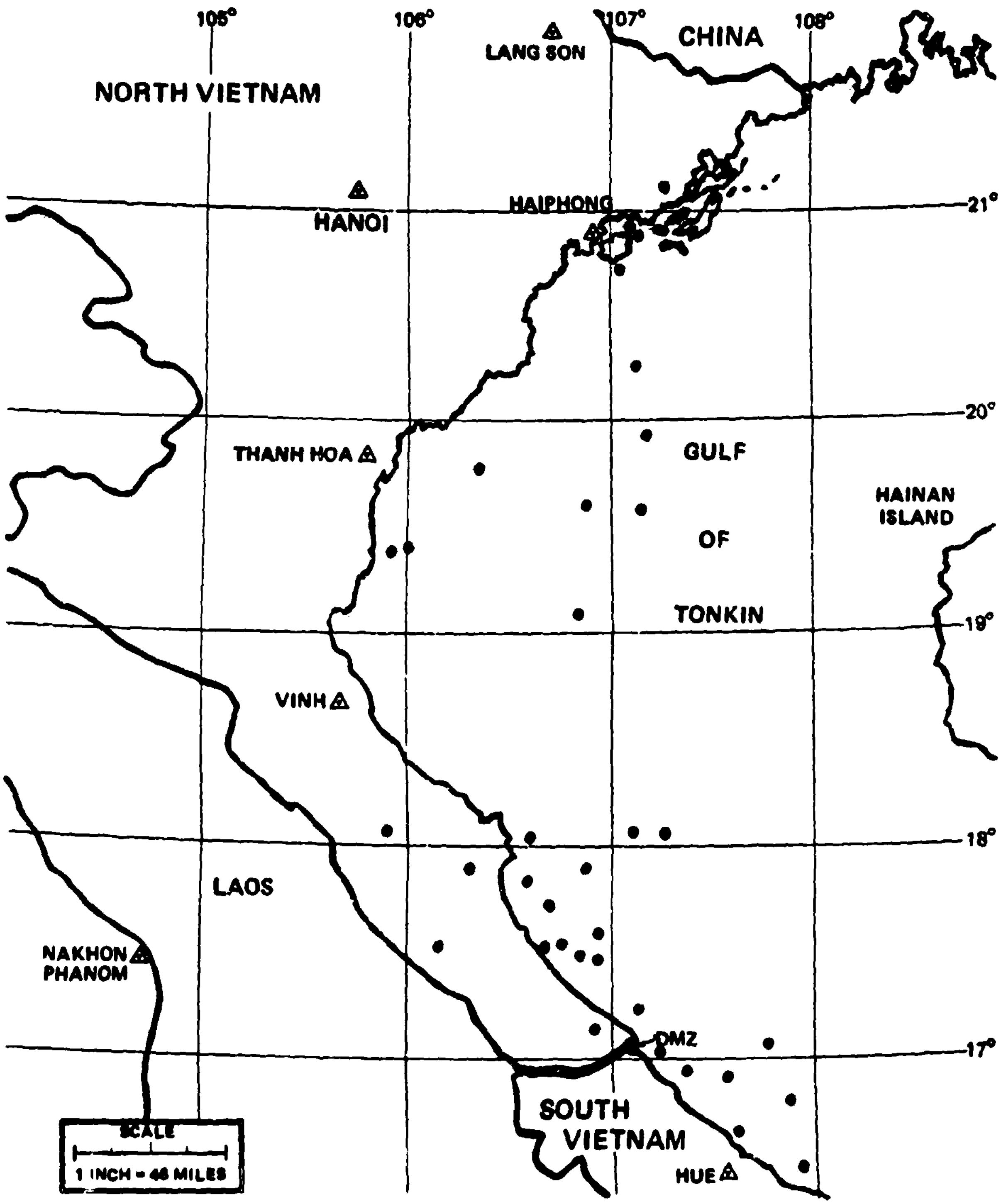

Figure 4. Locations of Navy rescues of Air Force aircrewmen during the Southeast Asia conflict.

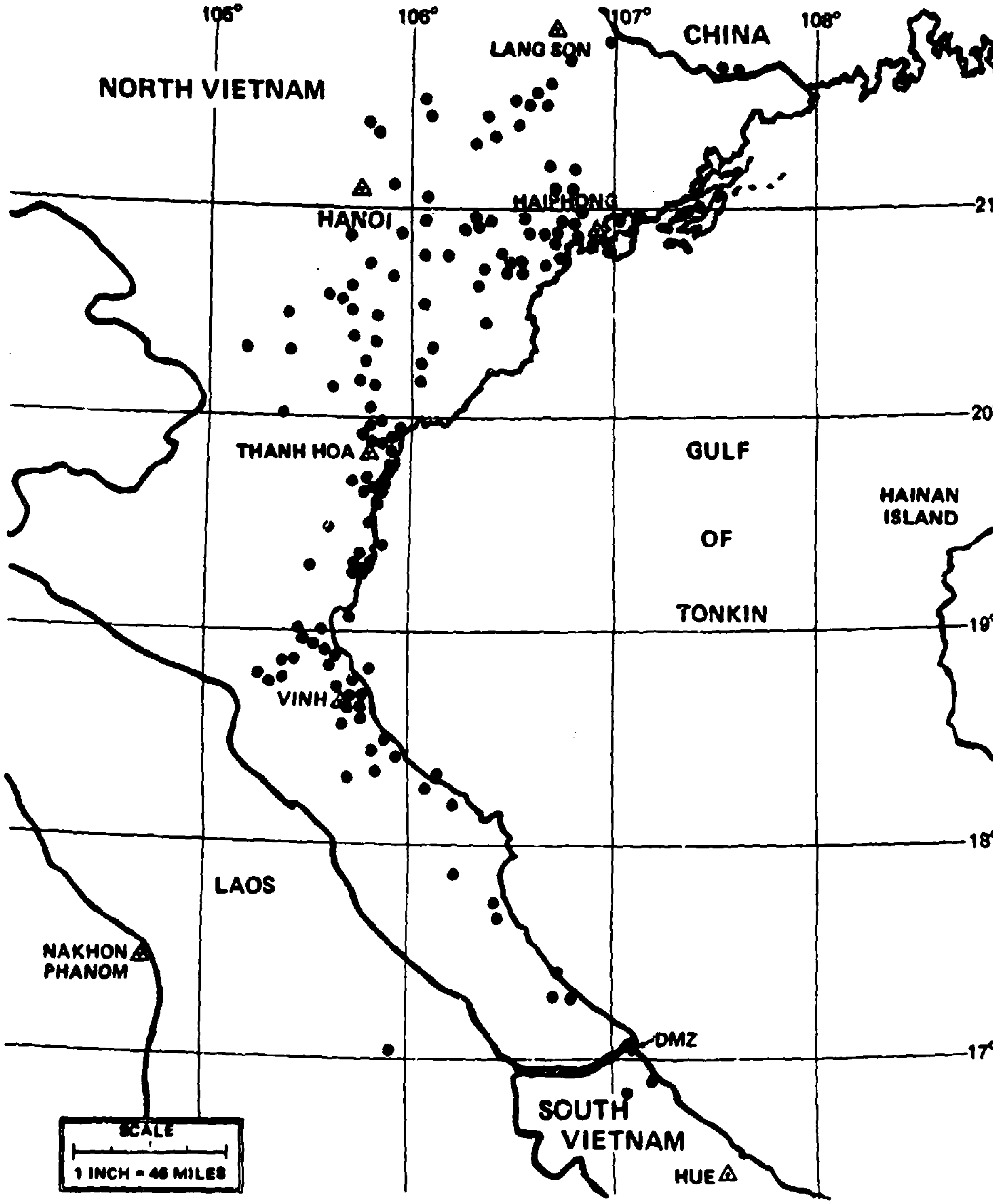

Figure 5. Known ejection locations of fixed wing Navy aircrewmen who became prisoners of war during the Southeast Asia conflict.

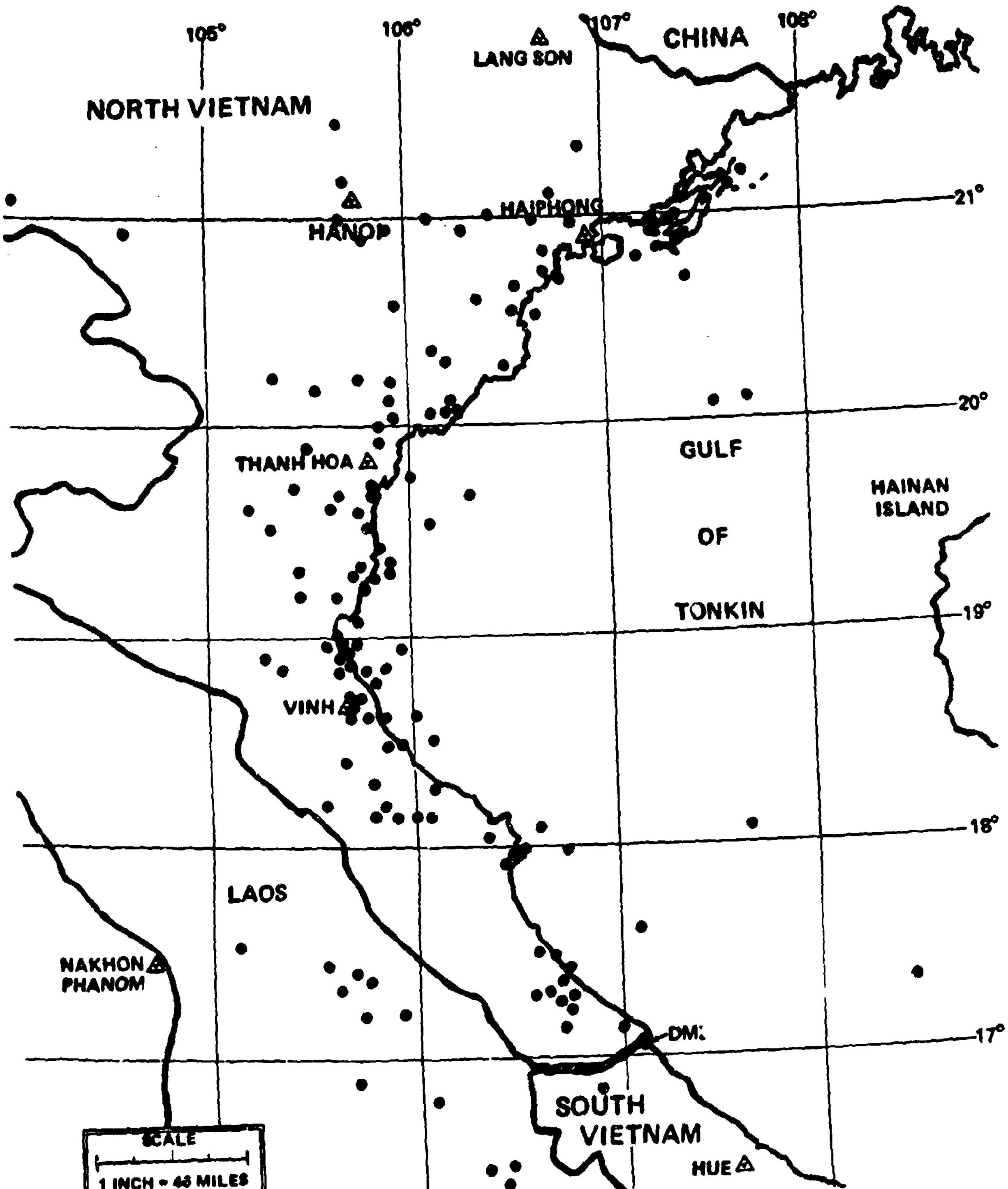

Figure 6. Known ejection locations of fixed-wing Navy aircrewmen who were missing or killed in action during the Southeast Asia conflict.

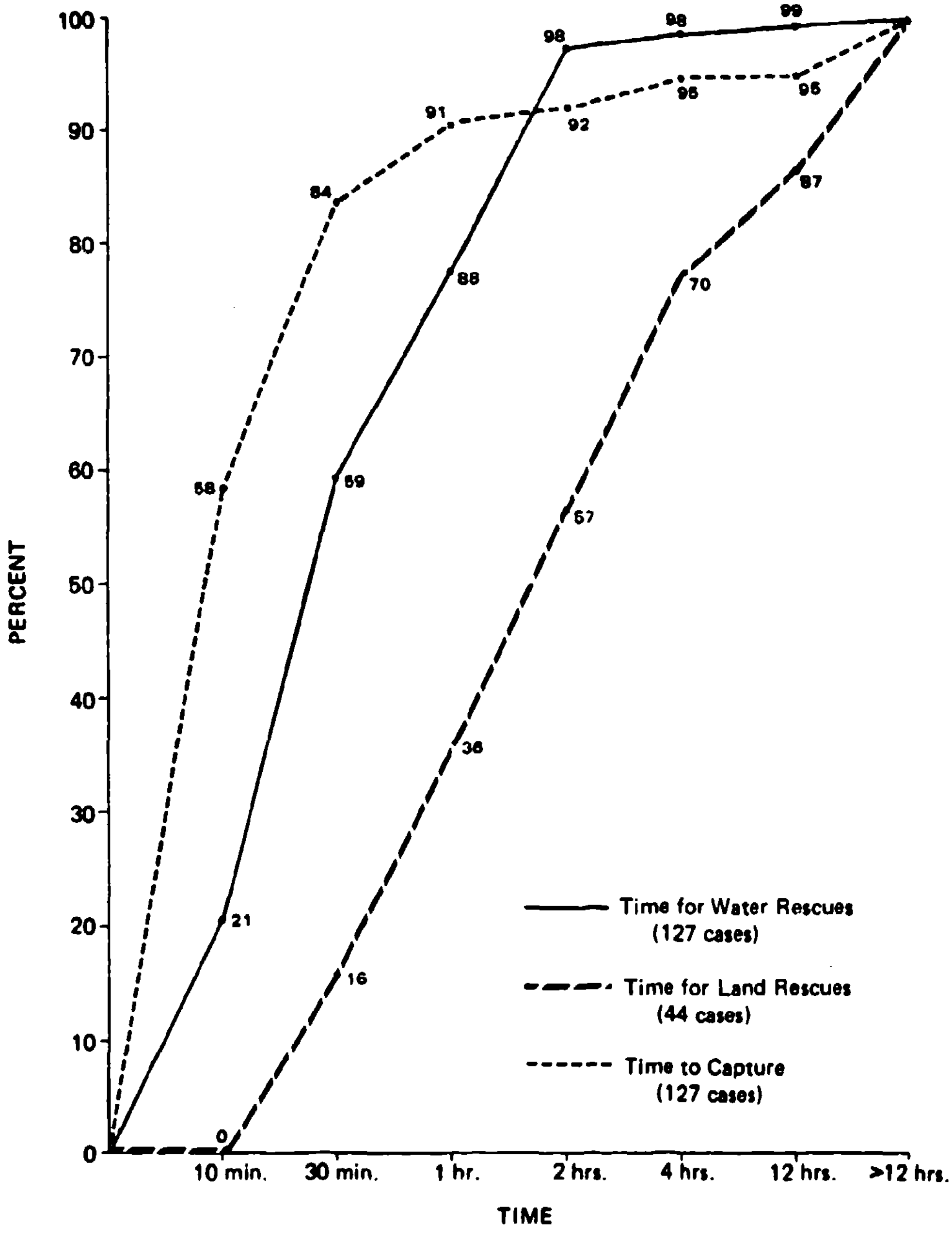

Figure 7. Cumulative percent of times to rescue compared with times to capture.

Table 3

Terrain and Vegetative Features at
Survival Site vs. Status

	Percent	
	Recovered	Prisoner of War
Open Ocean – Deep Water (N = 190)	96%	4%
In Shore, Open Areas, Lakes, Marshes, Rice Paddies, Populated Areas (N = 125)	15%	85%
Thick Jungle, Trees, Heavy Vegetation (N = 21)	91%	9%

Another factor possibly affecting survival was the distance of the ejection point from the location of a prison complex, in this conflict, the Hanoi area. Figure 8 plots the recovery status by latitude for those aircrewmen who were shot down in North Vietnam. This figure shows that the percent who did not survive (MIA/KIA) increases as the distance from the Hanoi "prison complex" area increases. While it is beyond the scope of this report to speculate on all of the causes for this, one contributing factor may have been the distance from the ejection location to the Hanoi prison complex in conjunction with the severity of the ejection injuries. The trip to the Hanoi area under the conditions found in Southeast Asia often required many days and the severity of the injuries together with a lack of proper medical attention may have been instrumental in reducing the survival rate during the trip.

The geographical location of the ejection survival site also had an influence on the ultimate status of the survivor. Table 4 shows the geographical location of the survival site versus the status of the downed aircrewman.

Table 4

Official Status of Navy Aircrewmen vs.
Geographic Location of Survival

Location

Status	NVN	LAOS	SVN	At Sea	Total
Recovered	29	33	20	181	263
Prisoner of War	138	2	3	17	160
Missing or Killed in Action	154	32	13	53	252
Total	321	67	36	251	675

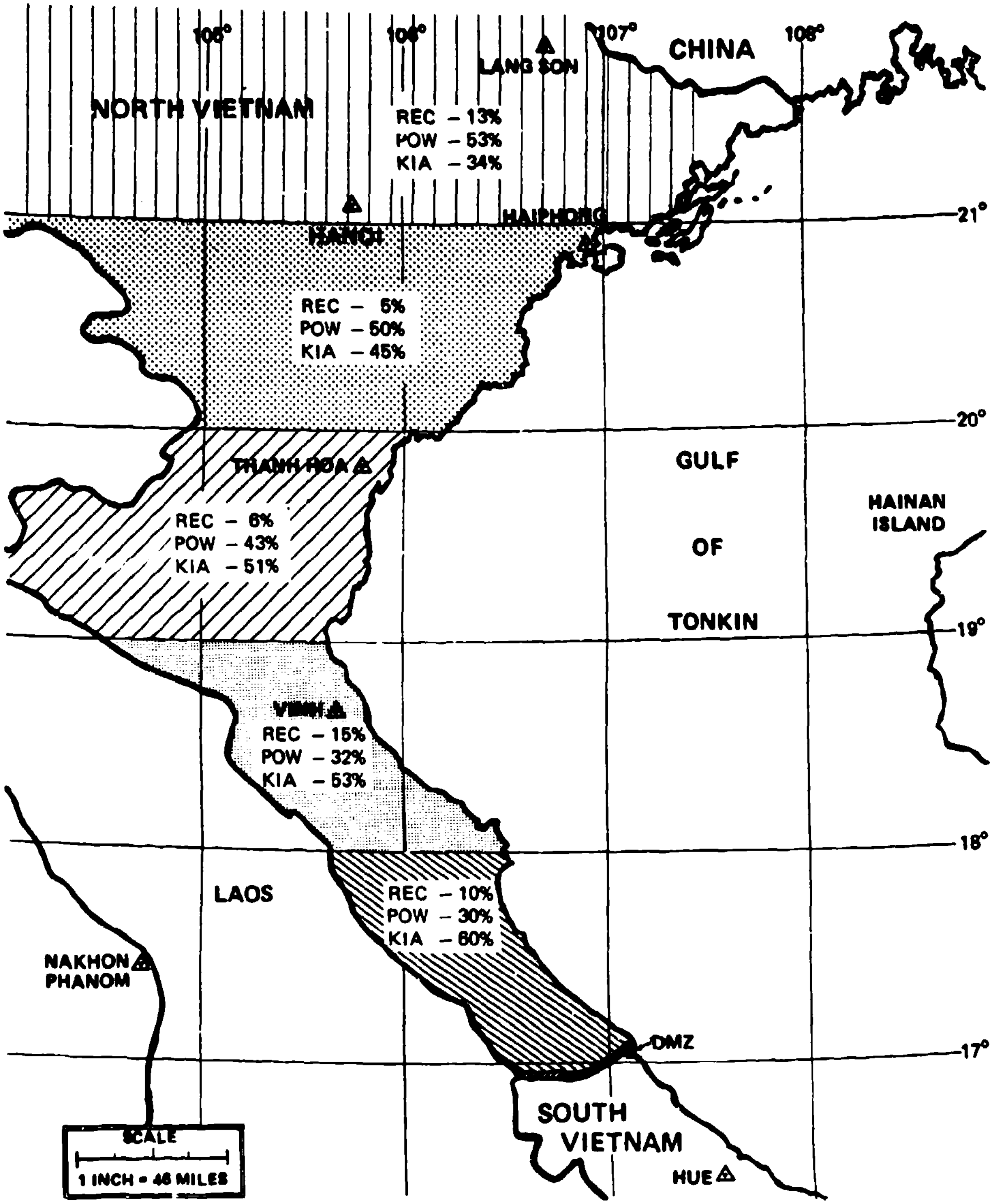

Figure 8. Official status of Navy aircrewmen ejecting over North Vietnam–by latitude.

FINDINGS AND DISCUSSION

Combat SAR Loss/Recovery Rates

The previous section discussed Navy combat SAR in terms of organizational structure, equipment utilized, vegetative and topographic characteristics of survival areas, and geographic location of the downed aircrewmen. Some of these parameters were definitely causal in the ultimate success or failure of the SAR rescue as well as in the loss of SAR personnel or craft. This section presents summaries and compares SAR loss to rescue rates for downed Air Force and Navy aircrewmen in the various sectors of SEASIA. The figures used in this section represent those losses and recoveries where the location of the survivor and branch of service for the recovery unit were definitely known. The summary for the Air Force SAR Loss/Rescue is presented in Table 5, and the summary for the Navy SAR Loss/Rescue is presented in Table 6. In these tables, SAR aircraft loss per rescue is defined as the ratio of SAR aircraft shot down per aircrewman rescued. SAR personnel loss per rescue is defined as the ratio of SAR personnel killed or captured per aircrewman rescued. Both of these tables are broken down into sections, with the first section presenting summaries for all of SEASIA, the second for North Vietnam, Laos, and South Vietnam only, and the third for North Vietnam only. Section 2 is deleted for the Navy because there were no combat recoveries performed in either Laos or South Vietnam by the Navy.

The differences in the loss per rescue ratios between the Air Force and Navy for all of SEASIA are due primarily to the large number of relatively safe open-ocean rescues made by the Navy. Once these safe areas (open-ocean, Cambodia, Thailand) are eliminated from the tables, the loss per rescue ratios increases dramatically.

Fixed-wing SAR losses were caused by almost the entire spectrum of anti-aircraft weaponry found in North Vietnam. Aircraft shot down at lower altitudes, e.g. below 6,000 ft., were predominantly downed by a mixture of aimed and barrage fire from 37 and 57 mm guns. At higher altitudes, losses were primarily from 85 mm weaponry and SAM missiles. Helicopters were vulnerable to small-arms fire because of their lack of speed and their requirements for a low hover during recovery operations. Late in the war another weapon increased the hazard. This was the SA-7 (STRELA) surface-to-air missile. It was man-portable, fired from the shoulder, and possessed an infrared-sensing homing system. This missile was a great threat to helicopters and slow-flying aircraft.

Table 5

Summary of Southeast Asia
Air Force Combat SAR Losses per Rescue

I. All Southeast Asia Combat

A. Rescues of:

Air Force + Navy = Total
484 + 57 = 541

B. Air Force SAR Aircraft Losses

Fixed Wing + Helicopter = Total
67 + 23 = 90

C. Air Force SAR Personnel Losses

Killed in Action + Prisoner of War = Total
51 + 10 = 61

D. SAR Loss per Save

SAR Aircraft

$\frac{541}{90}$ = 1 Loss per 6 Rescues

SAR Personnel

$\frac{541}{61}$ = 1 Loss per 8.9 Rescues

II. Only North Vietnam, Laos, and South Vietnam Excludes Safe Areas, e.g., open water, Cambodia, Thailand).

A. Rescues of:

Air Force + Navy = Total
367 + 32 = 399

B. Air Force SAR Aircraft Losses = 87

C. Air Force SAR Personnel Losses = 58

D. SAR Loss per Save

SAR Aircraft

$\frac{399}{87}$ = 1 Loss per 4.6 Rescues

SAR Personnel

$\frac{399}{58}$ = 1 Loss per 6.9 Rescues

III. North Vietnam Only

A. Rescues of:

Air Force + Navy = Total
93 + 5 = 98

B. Air Force SAR Aircraft Losses = 22

C. Air Force SAR Personnel Losses = 19

D. SAR Loss per Save

SAR Aircraft

$\frac{98}{22}$ = 1 Loss per 4.5 Rescues

SAR Personnel

$\frac{98}{19}$ = 1 Loss per 5.2 Rescues

Table 6

Summary of Southeast Asia Navy Combat SAR Losses per Rescue

I. All Southeast Asia Combat

A. Rescues of:

Air Force 59 + Navy 178 = Total 237

B. Navy SAR Aircraft Losses

Fixed Wing 13 + Helicopter 6 = Total 19

C. Navy SAR Personnel Losses

Killed in Action 12 + Prisoner of War 3 = Total 15

D. SAR Loss per Save

SAR Aircraft

$\frac{237}{19}$ = 1 Loss per 12.5 Rescues

SAR Personnel

$\frac{237}{15}$ = 1 Loss per 15.8 Rescues

II. Only North Vietnam (Excludes Safe Areas and No Combat Recoveries in Laos).

A. Rescues of:

Air Force 7 + Navy 20 = Total 27

B. Navy SAR Aircraft Losses = 19

C. Navy SAR Personnel Losses = 15

D. SAR Loss per Save

SAR Aircraft

$\frac{27}{19}$ = 1 Loss per 1.4 Rescues

SAR Personnel

$\frac{27}{15}$ = 1 Loss per 1.8 Rescues

The differences in recovery and loss rates for the services may be attributable to a number of factors including population density at survival site, SAR equipment available, capabilities of SAR personnel, vegetative characteristics of survival site, and the actions of the aircrewmen themselves. Generally it was found that when Navy pilots received aircraft damage which might require ejection they immediately turned toward the coast and attempted to get "feet wet" as quickly as possible. Unfortunately, many did not make the open ocean and were forced to eject in heavily populated (fortified) coastal areas. These locations, which were poor for escape and evasion, did offer the advantage of being relatively close to a safe area from which a SAR rescue vehicle could orbit and come in quickly for a pick-up. Table 7 gives the distance from the "feet wet" safe area versus time-to-capture, for the POW group, to show the time available to rescue these people and the distance that would have had to be covered to effect this rescue, prior to their capture.

Air Force procedures were somewhat different from those of the Navy. When an Air Force aircraft received a hit, the pilot would, in the majority of cases, turn back inland towards his own base and SAR units. If the damage was such that he was unable to make it all the way back to these bases, he was often over heavy jungle vegetation when he ejected which afforded him more time to evade. This heavy vegetation did, however, make parachute landing more dangerous and also made it more difficult to communicate with search forces.

Table 7

Distance From SAFE Area vs. Time on Ground Prior to Capture

Time to Capture	Distance from Feet Wet "SAFE" Area (miles)							
Minutes	In SAFE Area	1-5	6-10	11-20	21-30	31-50	51-90	Total
0-9	3	17	7	18	7	14	12	78
10-19	1	5	7	3	2		7	26
20-29			2		3	2	1	9
30-39		1	4	1		2	1	8
40-59			1				3	4
60-240		1	1				3	5
Over 240					1	3	4	8
Total	4	24	22	22	13	21	31	137

No matter where a survivor was downed over land in SEASIA, if he was not immediately captured, two factors, injury and communication, became important for his survival and rescue.

Previous reports from this study (Every, 1977; Every and Parker, 1976) demonstrated that combat ejection results in a large number of major injuries, the consequences of which severely affect the success of survival and rescue. Table 8 lists the percentages of fatalities and injuries sustained by Navy aircraft downed during combat over SEASIA. Table 9 lists additional injuries sustained by these survivors while on the ground.

Table 8

Degree of Severity of *non-fatal** injuries sustained during the combat mishap and prior to parachute landing by Navy aircrewmen.

Ejection Injuries

Major or Probably Major	Minor or Probably Minor	None or Probably None
32.7%	28.7%	38.6%

The location and types of major injuries, as well as the severity and time of occurrence, all affect a survivor's chances for evasion and rescue. Table 10 lists the more common types and locations of injuries associated with combat escape, with a discussion of the effect these injuries had on survival and rescue. In almost all cases, a major injury over land greatly jeopardized rescue crews and equipment because of the extended time required for the rescue.

Table 9

Degree and severity of additional injury incurred during landing or on ground by Navy aircrewmen known to have ejected following combat damage during the SEASIA conflict.

Fatal or Probably Fatal	Major or Probably Major	Minor or Probably Minor	None or Probably None
4%	5%	6%	85%

Table 10

Type and Location of Ejection and Landing Injuries and Their Effect on Survival and Rescue

Injury	Effect on Survival and Rescue
Unconsciousness	Precludes selection of landing location. Pilot is unable to communicate, activate signal equipment, evade, or aid in recovery.
Fractures and Dislocations of Lower Extremities	Prohibit evasion or getting to rescue area. Ejection injuries are easily compounded in landing. Pilot is unable to get quickly to rescue vehicle.
Fractures and Dislocations of Upper Extremities	Prevent parachute guidance. May prevent use of signaling equipment survival and rescue devices.
Lacerations and Burns	Cause blood or fluid loss which may lead to shock. Good chance for infection which would prevent long-term survival, or if captured under conditions found in SEASIA, result in high probability of death.
Vertebral Fractures	May cause paralysis. Painful for evasion. Good chance of aggravating during a landing survival or rescue effort.

Radio communications between the survivor and search aircraft and recovery helicopters was a critical factor in rescue. However, numerous SAR pilots reported needless communications on the SAR-designated frequency which proved both confusing and detrimental to the overall effort. While a number of survivors reported problems with survival radios, they nevertheless were considered to be the most important piece of survival equipment. When concealment was not a problem and the jungle canopy was not too thick, smoke flares were useful both for locating the survivor and for providing wind direction to the helicopter pilot.

Alternative to Conventional Air Combat Escape and Rescue

The first sections of this report outlined the Navy rescue structure and described some of the costs and problems associated with air combat escape and rescue. It is anticipated that in future air conflicts countermeasures against SAR forces will only be improved. The question then is, "Can we improve our rescue rate?"

Any discussion of alternative search and rescue systems must take into account the following factors which directly affect combat SAR:

1. *Vulnerability of Rescue Aircraft and Personnel.* The nature of the SAR mission and the types of aircraft employed make the search and recovery of a downed survivor extremely hazardous to SAR crews and equipment.

2. *Injury Condition.* The number and severity of injuries incurred during combat escape greatly restrict a downed airman's ability to evade the enemy and to assist during the pick-up sequence.

3. *Survivor Vulnerability.* Two elements are instrumental in decreasing chances for rescue. The first is that the survivor has little control over where he comes down; the second is that once he comes down in enemy territory, the likelihood of his being captured quickly is extremely high.

Several methods of rescue were experimented with during the SEASIA conflict. These methods were designed primarily to decrease the vulnerability of SAR craft and crews. One of these was the use of a drone helicopter to assist in rescue. The other was the air-to-ground pick-up. Neither of these methods proved satisfactory. While air-to-ground pick-up has been proven reliable under the right conditions, the heavy jungle vegetation and the quick capture rate made it generally unusable in SEASIA. Some flyaway and AERCAB concepts also were considered during this period. However, the weight of these systems and their general susceptability to combat damage made them unfeasible.

The analyses in this study suggest that to increase the rescue rate of downed aircrewmen and to decrease the vulnerability of search and rescue forces, the best alternative would be a system which incorporates recovery prior to the survivor reaching the ground, with conventional ground pick-up as a back-up.

Air-to-air pick-up systems were considered in earlier times. They were, however, not deemed feasible because analyses showed that with conventional ejection and descent systems, in the vast majority of cases, there would not have been enough "in-air" time to make the mid-air recovery. This "in-air" time is indeed the critical element in a successful air-to-air rescue system. The time must be sufficient for a SAR craft to come in, locate the survivor, and effect a pick-up at an altitude above the effective range of small-arms fire. In the past, use of conventional parachutes, which have no real glide or steerability and have a descent rate of approximately 20 to 24 feet/second, coupled with the requirement for fast ejection following combat damage, meant that only a limited number of successful air rescues could have been made.

The severity of aircraft damage during combat, which allows very little time prior to initiating ejection, is not expected to change in future combat operations. Other changes, however, may operate to increase the feasibility of an air-to-air rescue system. These include:

1. *The Ram-Air (Gliding) Parachute.*
   Ram-air/gliding parachutes are currently being evaluated by the Navy (Figure 9). These parachutes could offer a two-fold rescue advantage if used during a combat escape. Following ejection, this parachute would give even a relatively untrained pilot between a 3-to-1 and 5-to-1 controllable flight path. In most cases this would afford some choice in landing location. The slower descent would also allow SAR helicopters more time to get to the landing location prior to the survivor reaching ground. In an analysis of possible effectiveness, these glide ratios were used with the actual ejection altitudes and distances from the coast "safe area" for Navy prisoners of war to determine how many could have reached a safe area with these glide paths (Figure 10). The figures exclude the added problem of predominantly onshore winds, so it is evident that glide alone would have permitted only a relatively few aircrewmen to reach a "feet wet" safe area. In almost all cases, however, the maneuverability of the chute could have been used to reach a landing area where there might have been less likelihood of landing injury and/or better concealment, which would have permitted more time for escape and evasion. The primary advantage of these parachutes for air-to-air pick-up is their descent rate of around 10 to 14 feet/second. This descent rate offers almost twice the "in-air" time of existing parachute systems. As will be discussed later, it is this increased in-air time which enhances the potential recovery rate during combat.

2. *Vertical-Seeking Ejection Systems.*
   The new vertical-seeking ejection seats, such as the MPES* seat now under development, increase the height of the survivor above the ejection altitude, regardless of the aircraft attitude at the time of ejection. Future developments with these systems offer the possibility of

*Maximum Performance Ejection System

further increasing these altitudes by the addition of auxiliary sustainer rockets. This additional boost would allow these seats to reach even greater altitudes prior to parachute deployment.

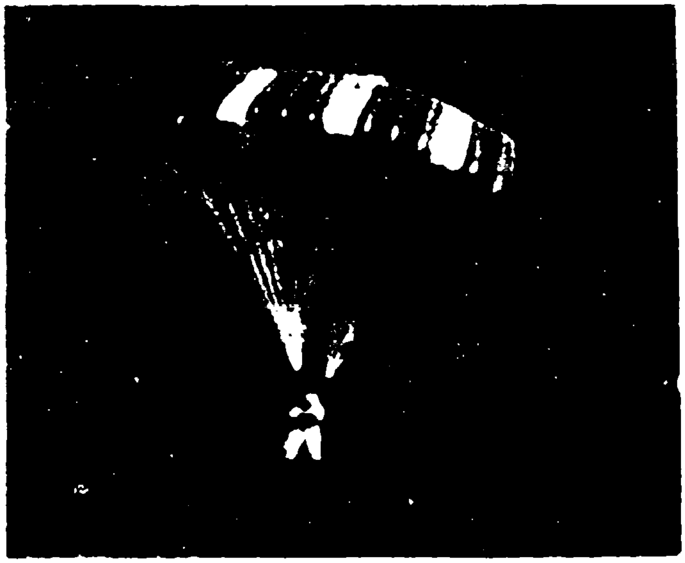

Figure 9. Ram-air parachute.
(Courtesy U.S. Navy)

3. *Survivor Locator Systems.*

   Electronic survivor locator systems showed rapid improvement during the SEASIA conflict. These personnel locator systems were especially effective when used above terrain features. State-of-the-art electronics today would readily permit the development of highly efficient locator systems. The primary receiver in the SAR aircraft would receive an alert signal immediately upon an aircrewman's ejection, followed by information as to the survivor's altitude, range, and bearing.

There are a number of advances and issues which bear on the mid-air recovery concept. These include:

1. *Air Retrieval Systems.*

   Ground-to-air pick-ups of live subjects utilizing the Fulton Skyhook system, as well as the mid-air retrieval of over 50 dummies and two live subjects using the All American Engineering system, were accomplished during the mid-1960's. Mid-air recoveries of nose cone packages and remote piloted vehicles are being performed routinely now using both fixed and rotary-wing aircraft.

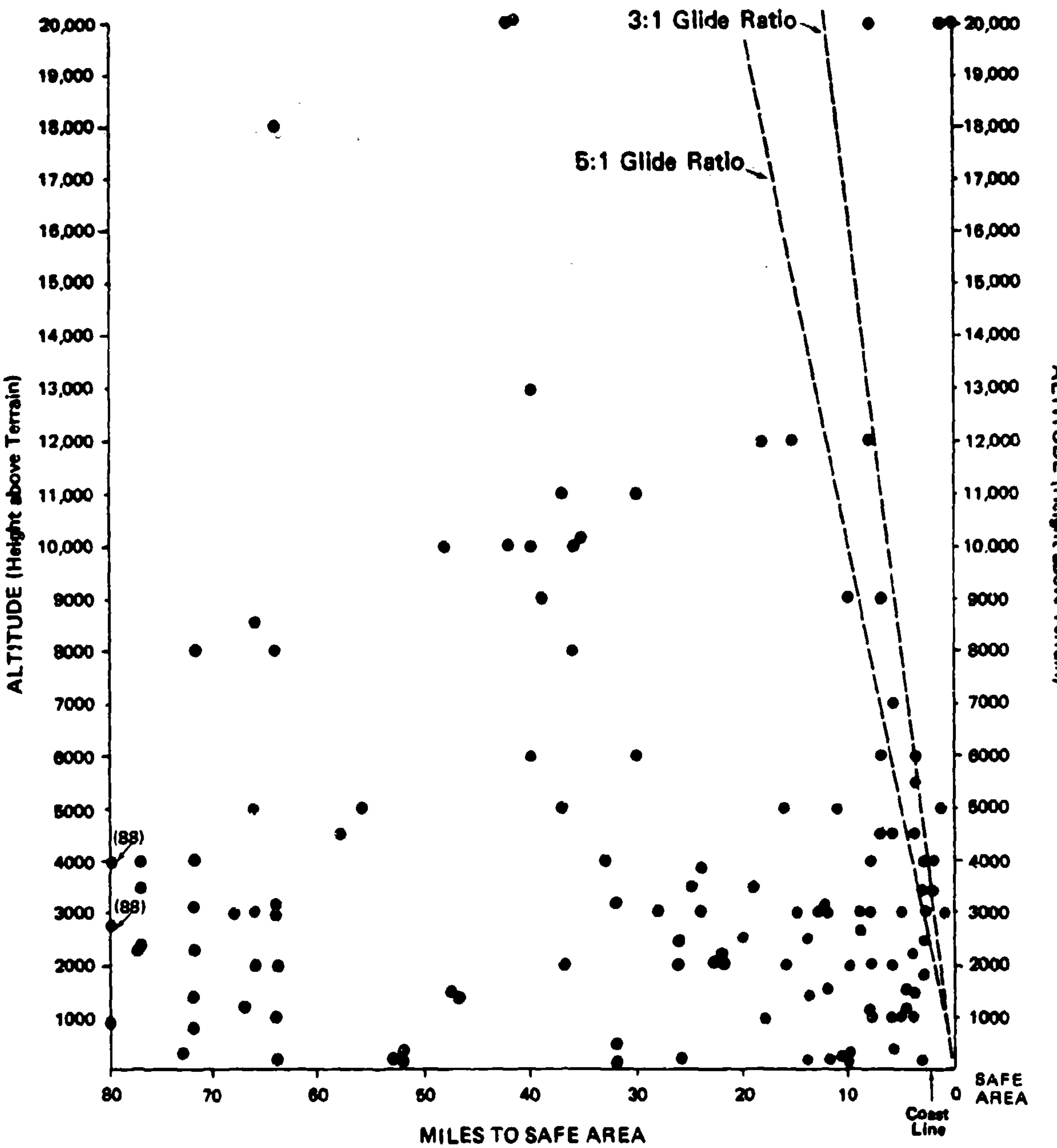

Figure 10. Potential glide-to-SAFE paths for Navy aircrewmen who became prisoners of war. Points represent actual ejection altitudes and distances from NVN coast.

2. *Air-Towing and Retrieval at High Speeds.*
   Reid et al (1972) conducted biomedical towing experiments with human subjects at the DOD Joint Parachute Test Facility, El Centro, California, and showed that subjects could be towed at speeds just over 170 KIAS for over 2½ minutes without adverse effects. Fatigue and stress to the neck muscles appear to be the immediate limiting factor in high speed towing. Support for the neck muscles might be achieved, however, by towing an aircrewman while he is still in the ejection seat. Research and testing will be required to establish this.

3. *New Rescue Vehicles.*
   Some V/STOL and VTOL aircraft concepts show promise in that one aircraft could be used for a mid-air rescue and, if necessary, change to hover to effect a land recovery. The AV-8 aircraft represents the pure jet engine aircraft approach which offers potential for a SAR role. Figures 11 and 12 illustrate two additional concepts that might also serve this dual role.

4. *Ejection Training.*
   With an operational mid-air rescue system, immediately after an aircraft received damage that made ejection seem likely, and unless there was a good possibility that the aircraft could reach a safe area, prior to ejection, the pilot's actions immediately following the damage would become crucial to his chances for aerial recovery. His primary responsibility would be to gain altitude as rapidly as possible and immediately alert search and rescue forces. Once maximum altitude was reached, he would maintain this altitude and continue to keep SAR aircraft informed of any change in his status. Many of these actions are contrary to the current practice of immediately using remaining aircraft power to get to a friendly area and then ejecting just within the lower limits of the safe ejection envelope.

Evaluation of Air-to-Air Rescue Concept Utilizing SEASIA Combat Data

Test Conditions

A model air-to-air pick-up system was formulated to determine how such a system might have worked under the conditions found in SEASIA. Model parameters include:

1. *Population.* All Navy aircrewmen who ejected over North Vietnam and were recovered or became prisoners of war plus those killed in action where there was enough data on their ejection were included. The escape information required for each ejectee was:
   (a) The height of the aircraft above terrain at the time of ejection
   (b) Altitude and speed at time of initial damage
   (c) Degree of pre-ejection injury
   (d) Controllability of aircraft prior to ejection
   (e) Time from initial combat damage until ejection was initiated
   (f) Distance to SAFE area (in these cases this was considered to be one to two miles into open water in the Gulf of Tonkin).

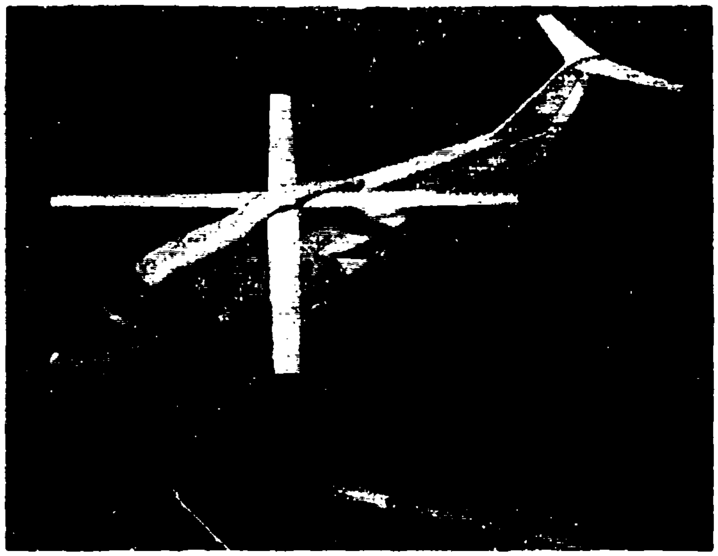

Figure 11. X-Wing Aircraft. This concept applies the features of the helicopter's rotating blades for vertical takeoffs and landings, then by locking the rotating wing, it operates as a fixed wing aircraft.

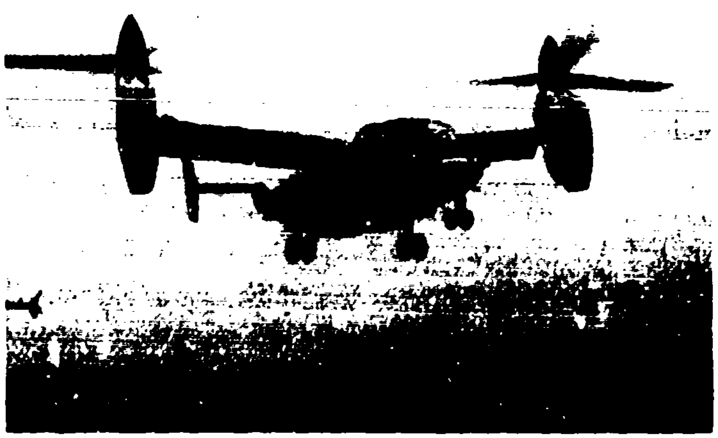

Figure 12. XV-15 Aircraft. Takes off, lands and hovers like a helicopter, the rotors swing down to the front for fixed-wing flight. *(Courtesy Bell Helicopter)*

2. *Ejection Conditions.* Two sets of tests were conducted. The first test was called *ACTUAL,* in that the actual height above the terrain at time of ejection was used in the computations. The second set was called *POTENTIAL.* In these tests, potential ejection altitudes were used. These potential altitudes were calculated based on the following: All of the previously-listed information was used to determine what altitude (up to 20,000 feet) could have been reached had the pilot, at the time of initial combat damage, made maximum use of his aircraft to gain altitude. Some general rules which were used included:

   (a) Of the time that the pilot had available between damage and ejection, the initial 5 seconds were used only to assess the damage and overcome shock.

   (b) The pilot could have no injuries which would prohibit his control of the aircraft. If his injuries were severe, the actual ejection altitude was also used for this test.

   (c) Climb rates of 45° at 400 KIAS, which is a vertical climb rate of 414 feet/second, or 30° at 293 feet/second, were used, depending on aircraft speed at time of damage and degree of damage. If the aircraft could not climb, actual ejection altitudes were used.

   (d) Once the aircraft reached 12,000 feet, the assumption was made that the pilot would eject before ever going below this altitude.

3. *SAR Rescue Craft.* The SAR rescue craft was assumed to be a fixed-wing jet aircraft having at least the performance characteristics of the Navy's S-3 (Viking) aircraft. The hypothetical SAR aircraft was equipped with an electronic locator system providing immediate and continuous range and bearing readings to the ejected survivor as well as continuous readings on his altitude. This SAR aircraft was in orbit at an altitude of approximately 16,000 feet and approached the air rescue site at the speed of 400 KIAS. The aircraft would proceed inbound immediately on notice of ejection or intention to eject. Once the SAR aircraft was in the vicinity of the aircrewmen, it would take two additional minutes to line up for the pick-up pass. For this study, no final passes were made below 2,000 feet above ground level.

   For these tests, two sets of SAR aircraft orbits were used. The first was an orbit approximately one to two miles off-shore directly in line with the strike or egress route. The second orbit was considered to be in the vicinity of the strike group, e.g., within three miles of the stricken craft. In both cases, the SAR craft was assumed to have headed for the ejected survivor either upon receipt of a communication of intent to eject or at the time of actual ejection.

4. *Parachute Descent Rates.* Parachute opening was always assumed to occur at ejection altitude. The parachute was of the RAM-air type, capable of a descent rate of 12 feet per second. Horizontal movement was ignored for these tests.

Test Results

Actual Ejection Altitudes

Figures 13, 14, and 15 present the *actual* ejection altitudes for the prisoner of war, recovered, and missing and killed in action groups who ejected over North Vietnam. Line "A" on these figures represents the cut-off altitude. For all points on or above the "A" line, it was calculated that these aircrewmen could have been picked up in the air by a SAR rescue craft coming in from the coastal orbit described earlier. Line "B" represents the minimum altitude considered necessary to eject in order to be rescued by the SAR craft which remained within three miles of the ejection location. Tables 11 and 12 summarize the percent air recoverable by status groups under both of these conditions.

Table 11

Summary of test results. Computed SEASIA combat Air-Air recoveries when rescue aircraft was at coastal orbit and ACTUAL ejection altitudes were used.

Status	No. Cases	% Recoverable
POW	125	25%
Recovered	23	17%
KIA	17	41%
Total	165	(mean) 26%

Table 12

Summary of test results. Computed SEASIA combat Air-Air recoveries when rescue aircraft was in area of ejection and ACTUAL ejection altitudes were used.

Status	No. Cases	% Recoverable
POW	125	42%
Recovered	23	39%
KIA	17	53%
Total	165	(mean) 43%

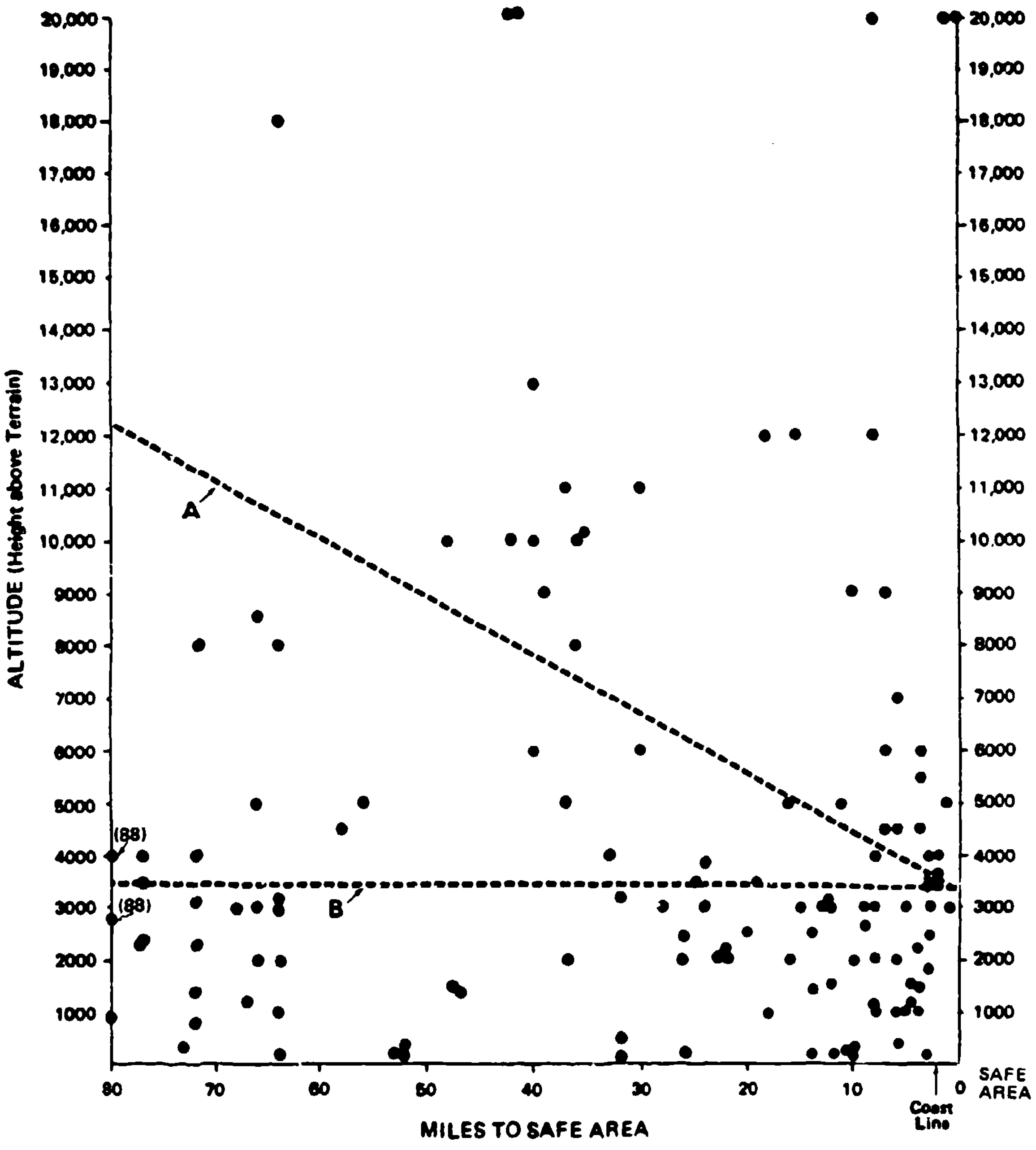

Figure 13. Actual ejection altitudes and distances from "feet wet" SAFE area for Navy aircrewmen who became prisoners of war. Distances beyond 80 miles are in parenthesis.

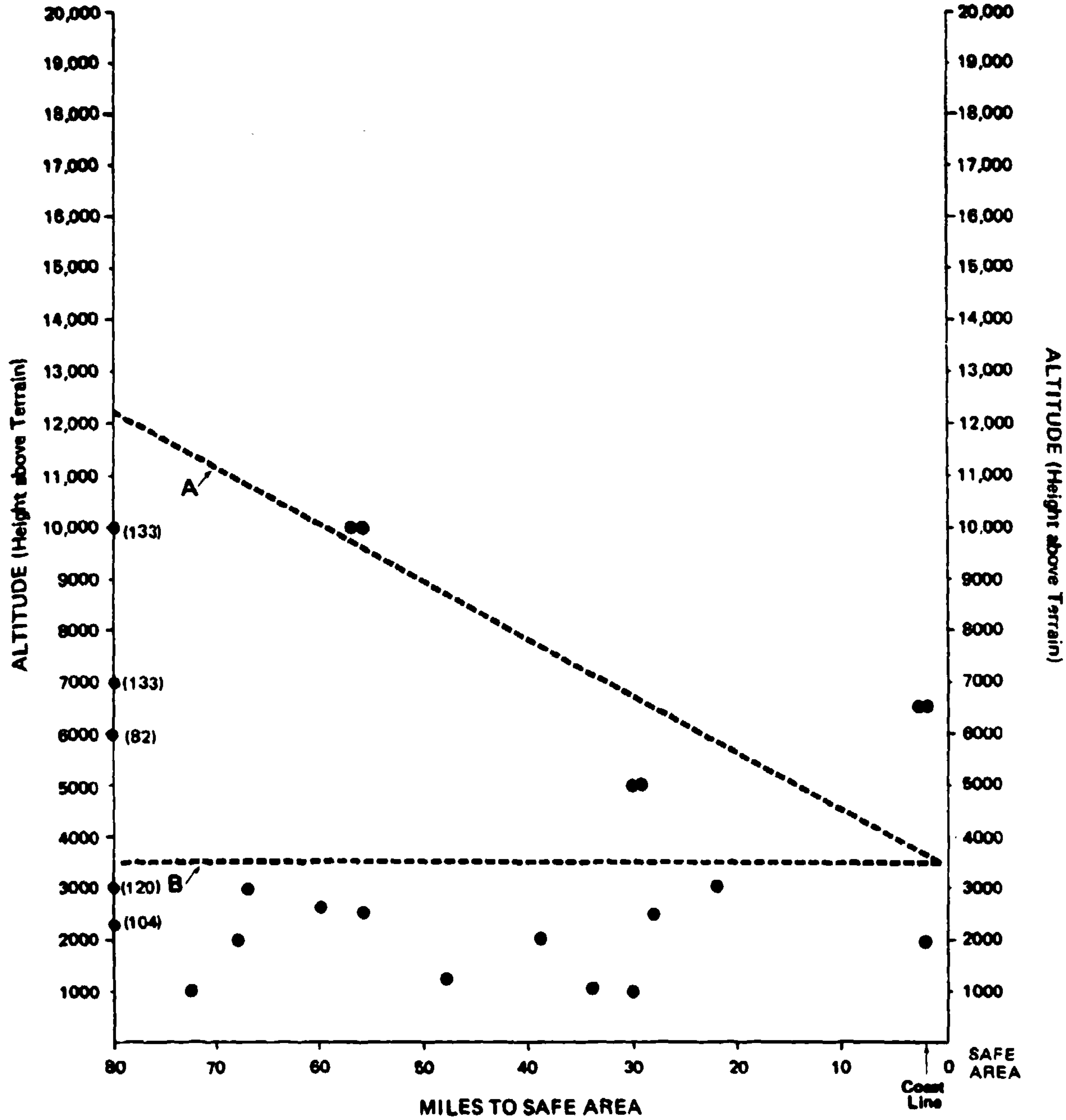

Figure 14. Actual ejection altitudes and distances from "feet wet" SAFE area for recovered Navy aircrewmen. Distances beyond 80 miles are in parenthesis.

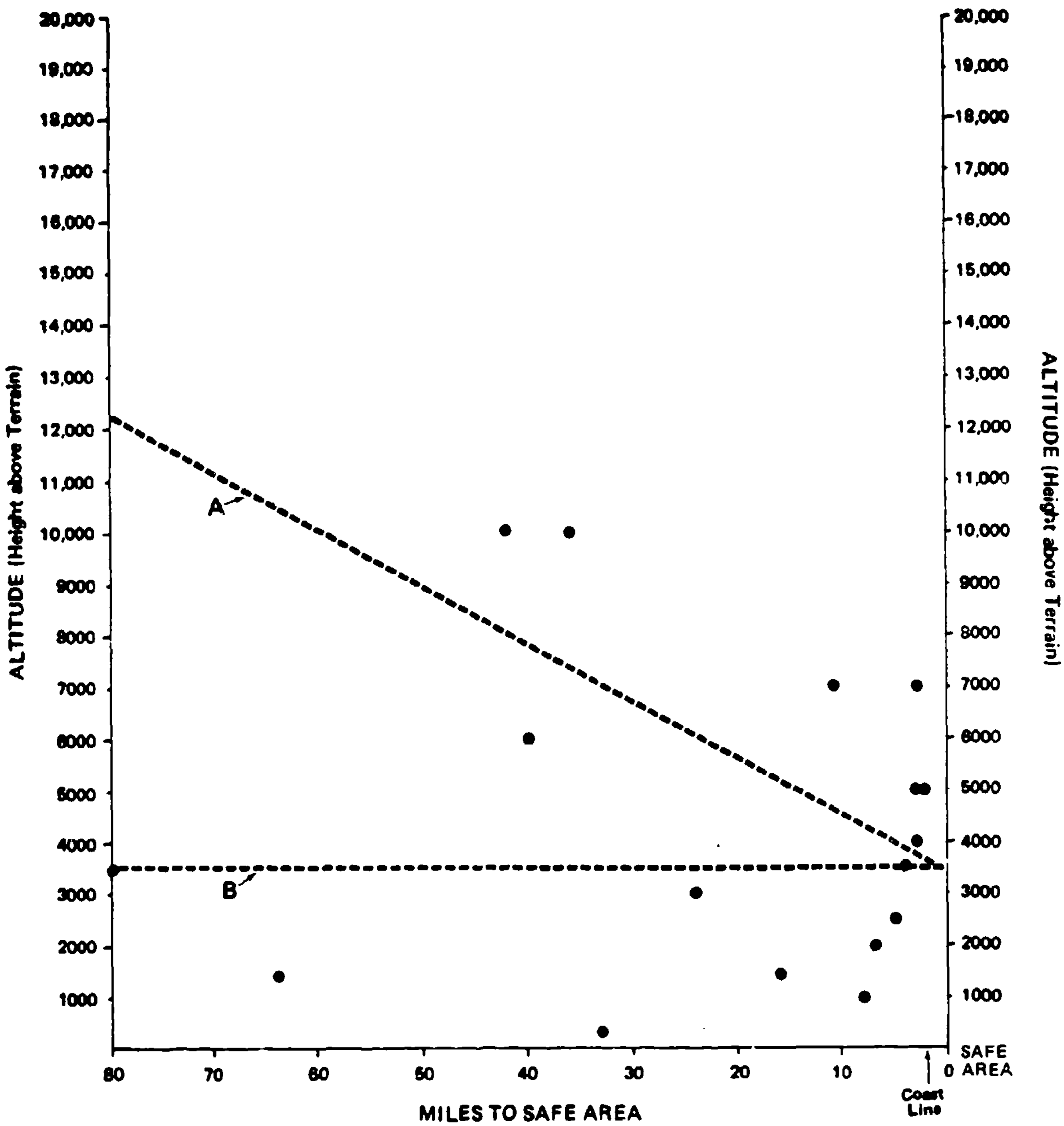

Figure 15. Actual ejection altitudes and distances from "feet wet" SAFE area for Navy aircrewmen listed as missing or killed in action.

Potential Ejection Altitudes

Figures 16, 17, and 18 present the distance to SAFE area versus the *potential* ejection altitude data points. The data points were established based on the conditions described earlier with line A and B representing the same as above. Tables 13 and 14 present the summaries from these figures by status group.

Table 13

Summary of test results. Computed SEASIA combat Air-Air recoveries when rescue aircraft was at coastal orbit and POTENTIAL ejection altitudes were used.

Status	No. Cases	% Recoverable
POW	132	42%
Recovered	25	64%
KIA	12	67%
Total	169	(mean) 47%

Table 14

Summary of test results. Computed SEASIA combat Air-Air recoveries when rescue aircraft was in area of ejection and POTENTIAL ejection altitudes were used.

Status	No. Cases	% Recoverable
POW	132	64%
Recovered	25	72%
KIA	12	83%
Total	169	(mean) 67%

It is of interest to note that in the recovered group for the actual ejection altitudes, only 17 to 39 percent, and for the potential group, only 64 to 72 percent, would have been recovered by air-to-air pick-up. This shows the need for conventional helicopters or some V/STOL aircraft to supplement the air-to-air pick-up concept.

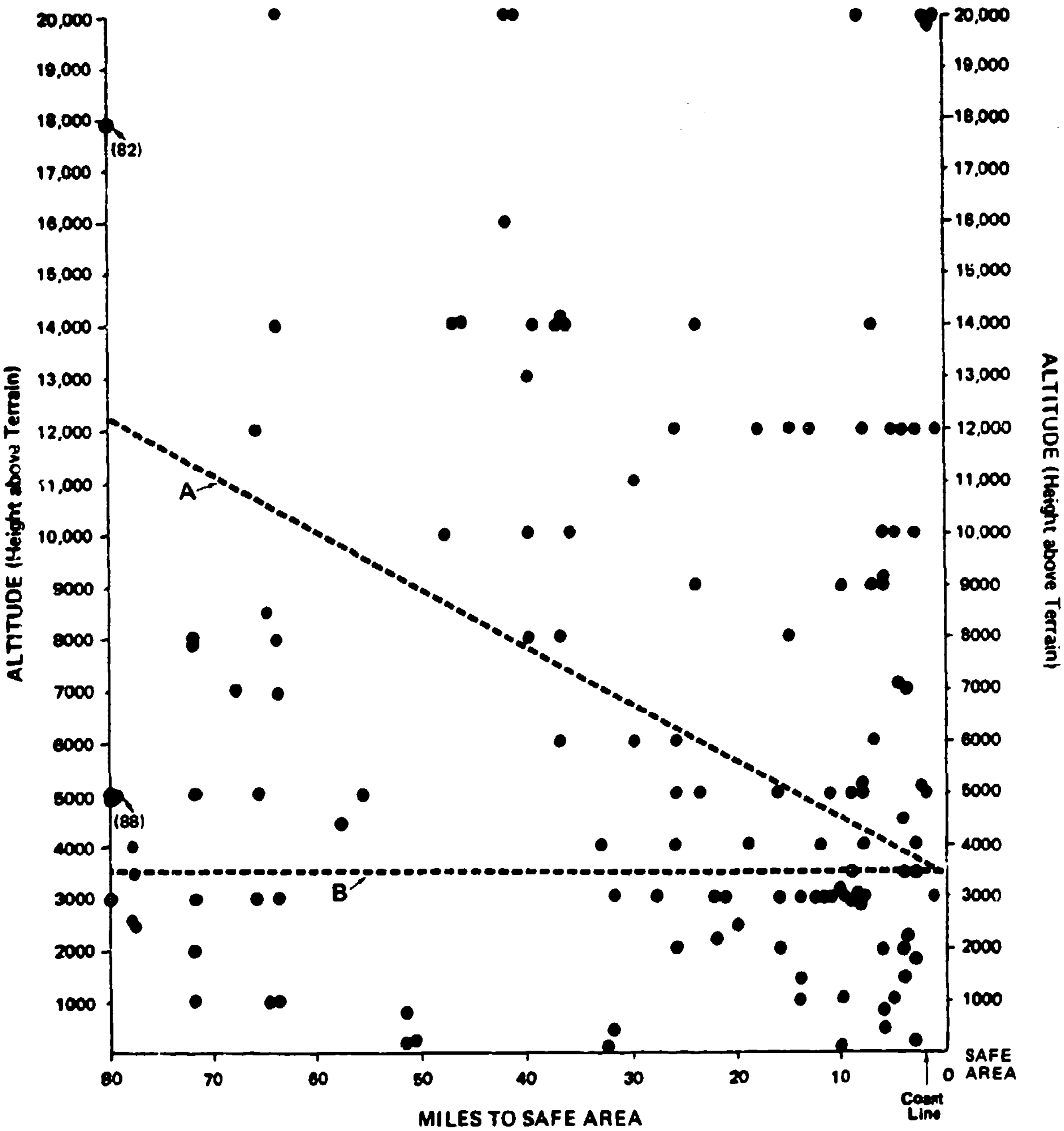

Figure 16. Potential ejection altitudes and distances from "feet wet" SAFE area for Navy aircrewmen who were listed as prisoners of war. Distances beyond 80 miles are in parenthesis.

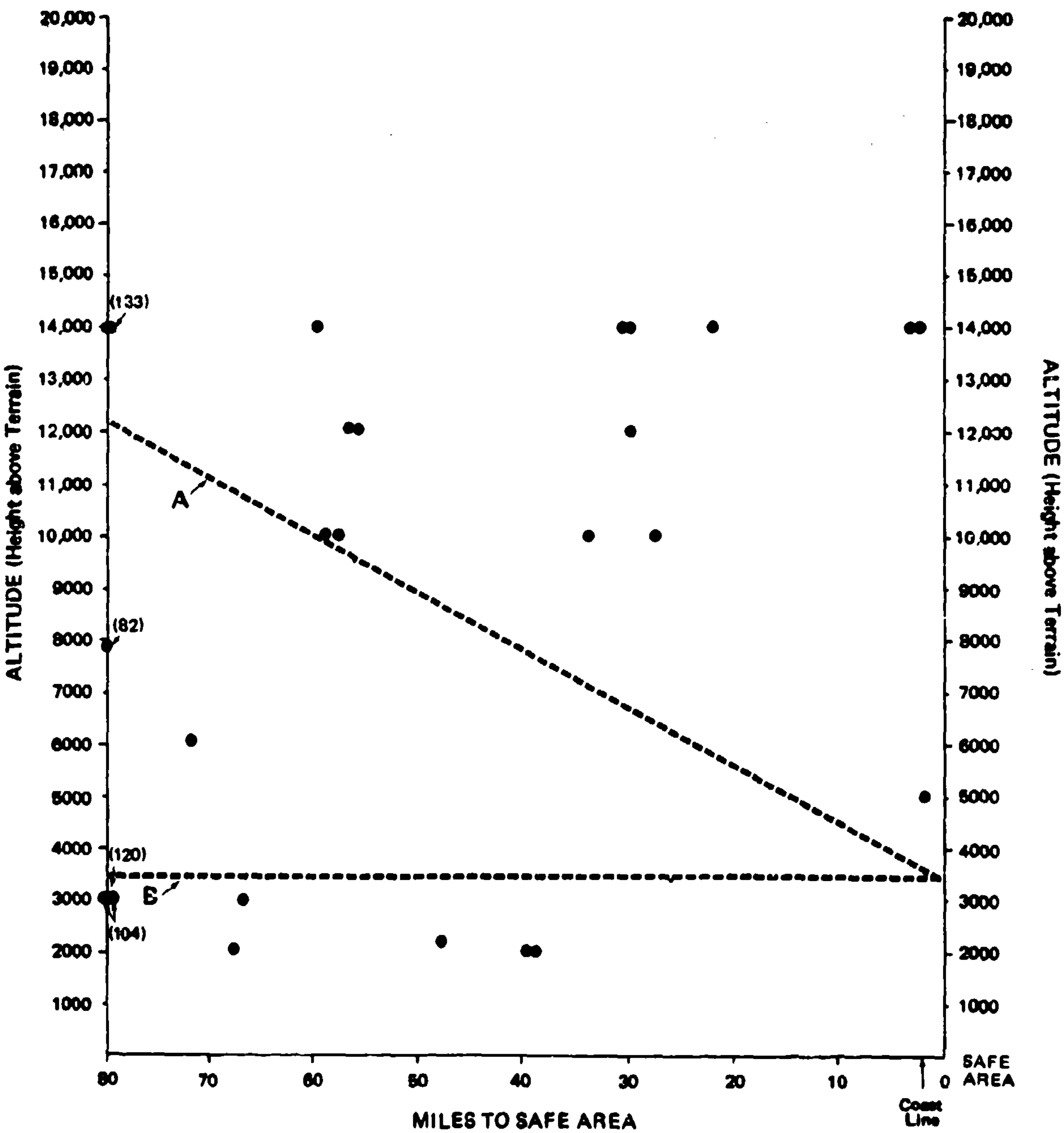

Figure 17. Potential ejection altitudes and distances from "feet wet" SAFE area for recovered Navy aircrewmen. Distances beyond 80 miles are in parenthesis.

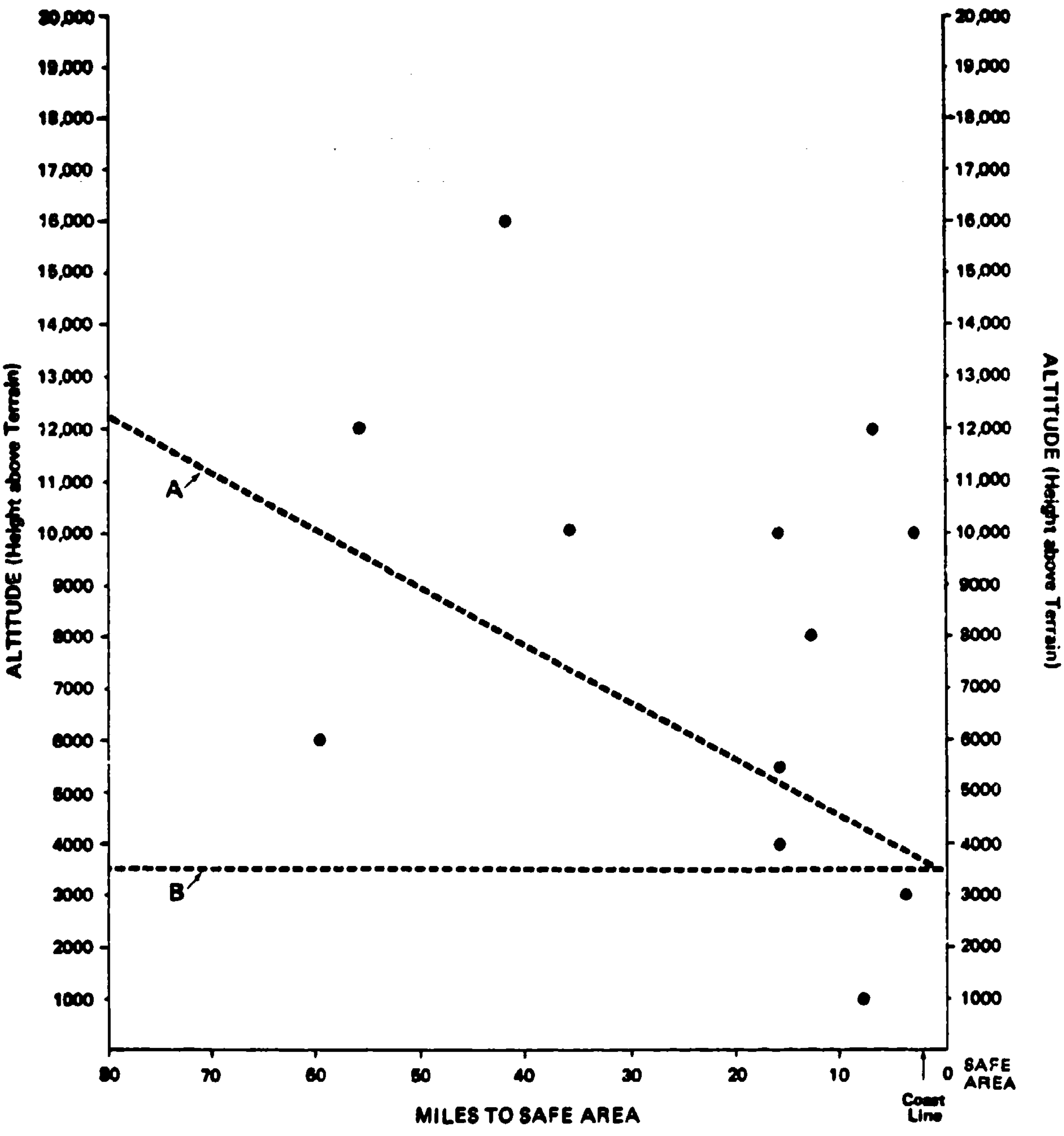

Figure 18. Potential ejection altitudes and distances from "feet wet" SAFE area for Navy aircrewmen listed as missing or killed in action.

SUMMARY

This report examines Navy combat Search and Rescue (SAR) operations and discusses those areas which influence the effectiveness of the different phases in the aircraft escape through rescue process.

Approximately 40 percent of the Navy aviators downed during combat in Southeast Asia were rescued. Over 30 percent, however, are known to have ejected, i.e. were rescuable at the moment of aircraft egress, and either became a Prisoner of War (28 percent) or were listed as Missing or Killed in Action. The moral, financial, and political cost of the loss of these aviators was beyond dollar value.

The Navy's role in combat SAR was considerable. As an element of the Southeast Asia SAR team, Navy SAR forces accomplished almost two hundred rescues from the Gulf of Tonkin and over 30 from inside North Vietnam. The Navy suffered no combat-related SAR losses during open-water rescues in the Gulf of Tonkin. They did, however, suffer a significant loss rate of one SAR vehicle and one SAR crewman for less than two rescues accomplished inland or from the protected waters off the coast of North Vietnam.

The population densities, vegetative characteristics, and vast array of anti-aircraft weaponry in the areas surrounding the Navy's principal targets in North Vietnam greatly decreased the chances of rescue for an aviator forced to eject prior to reaching the coast. Time to capture was generally short and SAR craft were highly susceptible to anti-aircraft fire during the rescue effort. Survival and rescue was often complicated by disabling ejection or parachute landing injuries. These injuries were often severe enough to prohibit evasion and aiding during the rescue. The extra time required to rescue these injured survivors made the SAR craft and crews extremely vulnerable to small-arms fire and portable surface-to-air missiles.

Previous reports during this study attest to the success of current ejection systems in allowing a large number of naval aviators to escape from disintegrating aircraft at the extreme limits of the "safe" ejection envelope. Continuing improvements, such as the Maximum Performance Ejection System, and new parachute systems will further increase this escape capability. It is concluded from the data in this study, however, that to improve significantly the rescue rate of aviators downed dur-

ing combat, alternative systems of rescue must be examined. These systems must work in conjunction with conventional SAR systems and must decrease the vulnerability of combat SAR crews.

A mid-air retrieval system was modeled using both "actual" and "potential" ejection data from the Navy aviators downed over North Vietnam. Depending on the location of the air rescue vehicle, possible rescue rates for the Prisoner of War group ranged from 25 to 64 percent. One condition imposed on this model was that a RAM-air type parachute be used to give a slower descent time. Even if the mid-air system were not used the glide characteristics of this chute offer an aircrewman a wider choice in selecting a suitable landing area.

In summary, Navy search and rescue forces performed heroically and well during the Vietnam conflict. Recovery statistics, however, coupled with data on loss rates for SAR personnel and equipment, show a need for continuing advances in the science of search and rescue. The Navy has developed and is continuing to improve its aircraft ejection systems. These systems permit escape from a catastrophically-damaged aircraft at speeds approaching Mach 1. In combat, however, elaborate ejection systems operate as only one part in the aircraft escape process. The process is not complete until the aviator is returned safely into friendly hands. Most of the technology for an advanced rescue system, one which would recover a high percentage of aviators and would lessen the danger for SAR forces, is already here. While a new system would require changes in conventional combat search and rescue procedures, principally involving mid-air recovery, the potential effectiveness in saving lives and equipment could be most impressive.

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APPENDIX A

NAVY COMBAT SAR DATA CODING MANUAL

Appendix A
NAVY COMBAT SAR DATA

Coding Manual

Category	Variable
ID Number	Direct Code
Date of Mishap	Day, Month, Year
Status Group & Reference Back to Individual Data File	Recovered Prisoner of War Missing or Killed in Action Prisoner Died in Captivity
Model Aircraft	A-4, A-6, A-7, F-4, F-8, RA-5C, OV-10, A-1, other
Mission	SAR, Rescap, Strike, Attack, other
Altitude at Time of Aircraft Damage	Direct Code (feet)
Speed at Time of Aircraft Damage	Direct Code (KIAS)
Latitude and Longitude at Time of Aircraft Damage	Direct Code
Method of Egress	Eject, Bailout, Crashland, Crash, Unable to Eject
Ejection Altitude	Direct Code (Ht. Above Sea Level)
Ejection Speed	Direct Code (KIAS)
Latitude and Longitude of Loss	Direct Code
Country of Loss	NVN, Laos, Cambodia, SVN, Open Ocean, Coast, Other
Injury Priot to Landing Degree of Additional Injury While on Ground Prior to Rescue or Capture Degree of Injury During Rescue	Fatal Prob. Fatal Major Prob. Major Minor Prob. Minor None Prob. None Unk—but known to be alive Died/Probably dies in crash
Terrain at Survival Site and/or Crash Site	Open Sea; Large Lake; River; Deep Water, Other; Shallow Water; Deep Snow; Thick Ice; Marsh/Swamp/Mud; Hard Ground; Soft Ground; Building; Flight Deck; Dense Woods or Jungle; In Trees; Ravine/Steep Slope; Rocks; In/Near Fireball; Desert; Unknown; Other; Over Land; Rice Paddies; Heavily Populated Area

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Appendix A
NAVY COMBAT SAR DATA (Continued)

Coding Manual

Category	Variable
Degree of Enemy Activity in Landing Area	Heavy Moderate Light None
Time to Capture or Rescue	Direct Code
Status of Recovery Attempt	Successful Unsuccessful, Survivors Not Located Unsuccessful, Hostile Fire, Capture Unsuccessful, Reason Unknown Rescue Not Attempted or Probably Not Attempted Body Recovered Unsuccessful (See Narrative)
Probable MIA/KIA Status On Ground	Known to Be Alive Severely Injured Alive But Injured Severely Died From Incident
Branch of Service Performing or Attempting Rescue	Navy, Air Force, Army, Marines, Air America, Others
Rescue Vehicle	Helicopter, Ship, Seaplane, Other
Base Location of Rescue Vehicle	Aircraft Carrier, Destroyer Cruiser, Land Based, Other
Type of Helicopter Making Rescue	H-2, H-3, H-46, H-53, H-43, H-34
Recovery or Attempted Recovery Site	Open Ocean Coast Waters < ½ mi. from Land Jungle Mountain, Karst Area Populated Area (town) Open Area Other
Equipment Used by Survivor to Signal Rescuer	From Equipment List
Did Rescue Crewman Leave Rescue Vehicle	Yes, No
Time to Accomplish Rescue from First Notification to Survivor into Rescue Vehicle	Direct Code
Distance to Rescue Site	Direct Code
Type of SAR Craft Damaged During SAR Effort	Helo, Fixed Wing
Degree of Damage to SAR Craft	Minor, Moderate, Heavy Strike
SAR Craft Personnel Killed or Injured	Direct Code
Survival, Rescue Equipment Used-Problems	From Equipment and Problem List
Degree of Search Effort	Heavy, Moderate, Light, None

Appendix A
NAVY COMBAR SAR DATA (Continued)

Coding Manual

Category	Variable
Miles to "SAFE" Area	Direct Code
Time of Search	Direct Code
Number of Fixed Wings A/C, Helicopters and Ships Utilized During Search	Direct Code

APPENDIX B

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Navy Combat Search and Rescue (SAR) information was collected from aircrewmen downed in Southeast Asia, Navy and Air Force records, and Missing and Killed in Action (MIA/KIA) files. This data was analyzed to evaluate the extent and effectiveness of Navy combat SAR, and to determine if indeed it functions as one continuous phase of the aircraft escape-to-rescue process. SAR mission success/loss rates are presented along with a discussion of the key factors which were causal in determining the success or failure of these missions. This report discusses possible alternatives to conventional combat SAR, such as mid-air recovery and shows how the combat data collected can be used to model some of these alternatives.

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